JALPAIGURI GOVERNMENT ENGINEERING COLLEGE
JALPAIGURI- 735102
(An Autonomous Government College)

COURSE STRUCTURE AND SYLLABUS
FOR
FIRST SEMESTER TO EIGHTH SEMESTER B.TECH. DEGREE

IN
CIVIL ENGINEERING

(Implemented for the new entry batch from the Academic Year 2021-22)

www.jgec.ac.in

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CC	SC	Subject Name	Contact Hrs. /Week		CC	SC	Subject name	Contact Hrs. /Week	
			L –T-P-TO	Cr.				L –T-P-TO	Cr.
BSC	BS-PH101	Physics	3-1-0-4	4	BSC	BS-CH201	Chemistry	3-1-0-4	4
BSC	BS-M101B	Mathematics-1B	3-1-0-4	4	BSC	BS-M201B	Mathematics-IIB	3-1-0-4	4
ESC	ES-CS101	Programming for Problem Solving	3-0-0-3	3	ESC	ES-EE201	Basic Electrical Engineering	3-1-0-4	4
BSC	BS-PH191	Physics Laboratory	0-0-3-3	1.5	HUM	HM-HU201	English	2-0-0-2	2
ESC	ES-CS191	Programming for Problem Solving Laboratory	0-0-4-4	2	BSC	BS-CH291	Chemistry Laboratory	0-0-3-3	1.5
ESC	ES-ME191	Workshop/Manufacturing Practice	1-0-4-5	3	ESC	ES-EE291	Basic Electrical Engineering Laboratory	0-0-2-2	1
Mandatory Induction Program- 3 weeks duration. It is to be done before initiation of classes (theoretical, laboratory & sessional) as per syllabus following guidelines of AICTE and MAKAUT					ESC	ES-ME291	Engineering Graphics & Design	1-0-4-5	3
					HUM	HM-HU291	Language Laboratory	0-0-2-2	1
			10-2-11-23	17.5				12-3-11-26	20.5
BSC	BS-M(CE) 301	Mathematics – III	2-1-0-3	3	HUM	HU-CE401	Value & Ethics in Profession	2-0-0-2	2
BSC	BS-CE301	Biology for Engineers	2-0-0-2	2	ESC	ES-CE401	Solid Mechanics	2-1-0-3	3
ESC	ES-CE301	Fluid Mechanics &Hydraulic Machines	2-1-0-3	3	PCC	PC-CE401	Concrete Technology & Construction Materials	3-0-0-3	3
PCC	ES-CE302	Engineering Mechanics	3-0-0-3	3	PCC	PC-CE402	Engineering Hydrology	3-0-0-3	3
PCC	PC-CE301	Surveying & Geomatics	2-1-0-3	3	PCC	PC-CE403	Soil Mechanics I	3-0-0-3	3
PCC	PC-CE302	Engineering Geology	2-1-0-3	3	PCC	PC-CE404	Environmental Engineering- I	3-0-0-3	3
MC	MC-CE301	Energy and Environmental Science	2-0-0-2	0	MC	MC-CE401	Essence of Traditional Knowledge	2-0-0-2	0
ESC	ES-CE391	Fluid Mechanics Laboratory	0-0-2-2	1	ESC	ES-CE491	Solid Mechanics Laboratory	0-0-2-2	1
ESC	ES-CE392	Computer-Aided Civil Engineering Drawing	0-0-3-3	1.5	PCC	PC-CE491	Concrete Technology Laboratory	0-0-2-2	1
PCC	PC-CE391	Surveying & Geomatics Laboratory	0-0-3-3	1.5	PCC	PC-CE492	Construction Material Laboratory	0-0-2-2	1
					PCC	PC-CE493	Soil Mechanics Laboratory	0-0-2-2	1
			15-4-8-27	21				18-1-8-27	21
PCC	PC-CE501	Design of RCC Structures	3-0-0-3	3	PCC	PC-CE601	Construction Engineering & Management	3-0-0-3	3
PCC	PC-CE502	Structural Analysis I	3-0-0-3	3	PCC	PC-CE602	Engineering Economics, Estimation & Costing	2-0-0-2	2
PCC	PC-CE503	Soil Mechanics II	3-0-0-3	3	PCC	PC-CE603	Water Resource Engineering	2-0-0-2	2
PCC	PC-CE504	Environmental Engineering II	3-0-0-3	3	PCC	PC-CE604	Design of Steel Structures	2-1-0-3	3
PCC	PC-CE505	Transportation Engineering	3-0-0-3	3	PCC	PC-CE605	Foundation Engineering	2-1-0-3	3
MC	MC-CE501	Constitution of India	3-0-0-3	0	PCC	PC-CE606	Structural Analysis II	2-1-0-3	3
PCC	PC-CE591	RCC Structures Design Lab.	0-0-2-2	1	OEC	OE-CE601	Open Elective I (Humanities) A: Soft Skills and Interpersonal Communication B: Introduction to Philosophical Thoughts C: Economic Policies in India	2-0-0-2	2
PCC	PC-CE592	Soil Mechanics Laboratory	0-0-2-2	1	PCC	PC-CE691	Steel Structure Design Sessional	0-0-3-3	1.5
PCC	PC-CE593	Environmental Laboratory	0-0-2-2	1	PCC	PC-CE692	Water Resource Engineering Laboratory	0-0-2-2	1
PCC	PC-CE59 4	Transportation Engineering Laboratory	0-0-2-2	1	PCC	PC-CE693	Quantity Survey, Estimation & Valuation Sessional	0-0-3-3	1.5
					PCC	PC-CE694	Computer Application in CE	0-0-2-2	1
			18-0-8-26	19				15-3-10-28	23
HUM	HU-CE701	Financial Management and Accounts	3-0-0-3	3	PEC	PE-CE801	Professional Elective VI A: Computational Hydraulics B: Hydraulic Structures C: Disaster Preparedness & Planning	3-0-0-3	3
OEC	OE-CE701	Open Elective II A: Metro System and Engineering B: ICT for Development C: Cyber Law and Ethics	3-0-0-3	3	OEC	OE-CE801	⁻Open Elective III A: Human Resource Development and Organizational behavior B: Deep Foundation C: Ground Water Contamination	3-0-0-3	3
PEC	PE-CE701	Professional Elective I A: GIS and Remote Sensing B: Pavement Design and	3-0-0-3	3	OEC	OE-CE802	Open Elective IV A: Soft Skills and Personality Development	3-0-0-3	3

		Construction C: Advance Foundation Engineering						B: Urban hydrology and hydraulics C: Environmental Impact Assessment and Life Cycle Assessment		
PEC	PE-CE702	Professional Elective II A: Pre-stressed Concrete B: Finite Element Method C: Repair and Rehabilitation of Structure	2-0-0-2	2		Proj	PR-CE881	Project II	0-0-12-12	6
PEC	PE-CE703	Professional Elective III A: Air and Noise Pollution and Control B:Physico-chemical Process for Water and Wastewater Treatment C: Water & Water Quality Modelling	2-0-0-2	2		Proj	PR-CE882	Comprehensive Viva Voce	0-0-0-0	1
PEC	PE-CE704	Professional Elective IV A: Structural Dynamics & Earthquake Engineering B: Advance Structural analysis C: Industrial Structure	2-0-0-2	2		Proj	PR-CE883	Seminar	0-0-0-0	1
PEC	PE-CE705	Professional Elective V A: Bridge Engineering B: Urban Transport Planning C: Railway and Airport Engineering	2-0-0-2	2		IN	PR-CE884	Internship Evaluation	0-0-0-0	0
Proj	PR-CE781	Project I (Project Work)	0-0-8-8	4						
			17-0-8 -25	21					9-0-12 -21	17

TOTAL CREDITS – [(17.5 +20.5) + (21+21) + (19+23) + (21+17)] =160

SEM 1 & SEM 2	SEM 3	SEM 4	SEM 5	SEM 6	SEM 7	SEM 8	Total
38	21	21	19	23	21	17	160

BS-M(CE)301	MATHEMATICS- III	2L + 1T	3 Credits
Module 1	**Partial Differential Equation(PDE):** Definition of Partial Differential Equations, First order partial differential equations, Solutions of first order linear PDEs , Solution to homogenous and non-homogenous linear PDEs of second order by complimentary function and particular integral method. Second-order linear equations and their classification, Initial and Boundary Conditions, D'Alembert's solution of one dimensional wave equation , Solution of one dimensional wave equation, one dimensional heat equation and two dimensional Laplace equation by separation of variables .		**10L**
Module 2	**Transform Calculus :** **Laplace Transform :** Laplace transform and its existence theorem, Properties of Laplace transform(Linearity, Shifting, Change of scale), Laplace transform of derivatives, Multiplication by t^n ,division by t, Laplace transform of periodic functions and step functions. Evaluation of improper integrals by Laplace transform, Finding inverse Laplace transform by different methods, Convolution theorem (statement only), Solving ODEs and PDEs by Laplace transform. **Fourier Transform :** Fourier Integral theorem(Statement only), Fourier transform and its properties (Linearity, Shifting, Change of scale, Modulation), Fourier transform of derivatives, Convolution theorem(statement only) ,Inverse Fourier transform, Application of Fourier transform to Initial Boundary Value Problems (IBVP).		**6L** **4L**
Module 3	**Probability** : **Basic Probability Theory**: Classical definition and its limitations, Axiomatic definition, Some elementary deduction: $P(\emptyset) = 0 , 0 \leq P(A) \leq 1, P(A') = 1 - P(A)$ etc. where the symbols have their usual meanings, Frequency interpretation of probability. Addition rule for two events (proof) & its extension to more than two events (statement only) and related problems, Conditional probability and Independent events , Extension to more than 2 events (pairwise and mutual independence) , Multiplication rule, Examples, Baye's theorem (statement only) and related problems. **Random Variable & Probability Distributions** : Definition of random variable, Continuous and discrete random variables, Probability density function & probability mass function for single variable only, Distribution function and its properties (without proof), Examples, Definitions of Expectation & Variance , properties & examples. Some Important Discrete Distributions: Binomial & Poisson distributions and related problems. Some Important Continuous Distributions: Uniform, Exponential, Normal distributions and related problems. Determination of Mean & Variance for Binomial, Poisson and Uniform distributions only.		**4L** **4L**

Module 8	**Graph Theory:** Basic concept of graph, Isomorphism, Walk, Path, Cycle, Circuit, Eulerian and Hamiltonian graph, Digraph, Matrix representation of graph: Incidence matrix and Adjacency matrix, Basic concept of Tree, Binary tree, Spanning tree, Kruskal and Prim's algorithm for finding minimal spanning tree.			**10 L**
References	**Sl.**	**Book Name**	**Author**	**Publishing House**
	1	Advanced Engineering Mathematics	Erwin Kreyszig	John Wiley & Sons
	2	Higher Engineering Mathematics	B. S. Grewal	Khanna Publishers,44th Edition
	3	Engineering Mathematics	Veerarajan T	Tata McGraw-Hill
	4	Elements of Partial Differential Equations	I. N. Sneddon	Dover Publications
	5	Schaum's Outline of Theory and Problems of Laplace Transforms	Murray R. Spiegel	McGraw-Hill,1965
	6	The use of Integral Transform	I. N. Sneddon	McGraw-Hill,1972
	7	A first Course in Probability Theory	S. Ross	Pearson Education India
	8	An Introduction to Probability Theory and its Application	W. Feller	Vol. 1,Wiley
	9	Mathematical Statistics	John E. Freund, Ronald E. Walpole	Prentice Hall
	10	Statistical methods (Combined Volume)	N. G. Das	Tata-McGraw-Hill
	11	Graph Theory	N. Deo	Prentice Hall of India,1974

BS-CE301	BIOLOGY (BIOLOGY FOR ENGINEERS)	2L + 0T	2 Credits
Module 1	**Introduction:** Bring out the fundamental differences between science and engineering by drawing a comparison between eye and camera, Bird flying and aircraft. Mention the most exciting aspect of biology as an independent scientific discipline. Why we need to study biology? Discuss how biological observations of 18th Century that lead to major discoveries. Examples from Brownian motion and the origin of thermodynamics by referring to the original observation of Robert Brown and Julius Mayor. These examples will highlight the fundamental importance of observations in any scientific inquiry. **Purpose:** To convey that Biology is as important a scientific discipline as Mathematics, Physics and Chemistry		**2L**
Module 2	**Classification:** Hierarchy of life forms at phenomenological level. A common thread weaves this hierarchy Classification. Discuss classification based on (a) cellularity- Unicellular or multicellular (b) ultrastructure- prokaryotes or eucaryotes. (c) energy and Carbon utilization -Autotrophs, heterotrophs, lithotropes (d) Ammonia excretion – aminotelic, uricoteliec, ureotelic (e) Habitataacquatic or terrestrial (e) Molecular taxonomy- three major kingdoms of life. A given organism can come under different category based on classification. Model organisms for the study of biology come from different groups. E.coli, S.cerevisiae, D. Melanogaster, C. elegance, A. Thaliana, M. musculus **Purpose:** To convey that classification per se is not what biology is all about. The underlying criterion, such as morphological, biochemical or ecological be highlighted.		**3L**
Module 3	**Genetics** Mendel's laws, Concept of segregation and independent assortment. Concept of allele. Gene mapping, Gene interaction, Epistasis. Meiosis and Mitosis be taught as a part of genetics. Emphasis to be give not to the mechanics of cell division nor the phases but how genetic material passes from parent to offspring. Concepts of recessiveness and dominance. Concept of mapping of phenotype to genes. Discuss about the single gene disorders in humans. Discuss the concept of complementation using human genetics. **Purpose:** To convey that "Genetics is to biology what Newton's laws are to Physical Sciences"		**4L**
Module 4	**Biomolecules** Molecules of life. In this context discuss monomeric units and polymeric structures. Discuss about sugars, starch and cellulose. Amino acids and proteins. Nucleotides and DNA/RNA. Two carbon units and lipids. **Purpose:** To convey that all forms of life has the same building blocks and yet the manifestations are as diverse as one can imagine		**4L**

Module 5	**Enzymes** Enzymology: How to monitor enzyme catalyzed reactions. How does an enzyme catalyse reactions. Enzyme classification. Mechanism of enzyme action. Discuss at least two examples. Enzyme kinetics and kinetic parameters. Why should we know these parameters to understand biology? RNA catalysis. **Purpose:** To convey that without catalysis life would not have existed on earth	**4L**
Module 6	**Information Transfer** Molecular basis of information transfer. DNA as a genetic material. Hierarchy of DNA structure from single stranded to double helix to nucleosomes. Concept of genetic code. Universality and degeneracy of genetic code. Define gene in terms of complementation and recombination. **Purpose:** The molecular basis of coding and decoding genetic information is universal	**4L**
Module 7	**Macromolecular analysis** Proteins- structure and function. Hierarch in protein structure. Primary secondary, tertiary and quaternary structure. Proteins as enzymes, transporters, receptors and structural elements. **Purpose:** How to analyses biological processes at the reductionistic level	**5L**
Module 8	**Metabolism** Thermodynamics as applied to biological systems. Exothermic and endothermic versus endergonic and exergoinc reactions. Concept of Keq and its relation to standard free energy. Spontaneity. ATP as an energy currency. This should include the breakdown of glucose to CO2 + H2O (Glycolysis and Krebs cycle) and synthesis of glucose from CO2 and H2O (Photosynthesis). Energy yielding and energy consuming reactions. Concept of Energy charge **Purpose:** The fundamental principles of energy transactions are the same in physical and biological world.	**4L**
Module 9	**Microbiology** Concept of single celled organisms. Concept of species and strains. Identification and classification of microorganisms. Microscopy. Ecological aspects of single celled organisms. Sterilization and media compositions. Growth kinetics.	**3L**
References	1. Biology: A global approach: Campbell, N. A.; Reece, J. B.; Urry, Lisa; Cain, M, L.; Wasserman, S. A.; Minorsky, P. V.; Jackson, R. B. Pearson Education Ltd 2. Outlines of Biochemistry, Conn, E.E; Stumpf, P.K; Bruening, G; Doi, R.H., John Wiley and Sons 3. Principles of Biochemistry (V Edition), By Nelson, D. L.; and Cox, M. M.W.H. Freeman and Company 4. Molecular Genetics (Second edition), Stent, G. S.; and Calender, R.W.H. Freeman and company, Distributed by Satish Kumar Jain for CBS Publisher 5. Microbiology, Prescott, L.M J.P. Harley and C.A. Klein 1995. 2nd edition Wm, C. Brown Publishers 6. Biology of Engineers, McGraw Hill (ISBN: 978-11-21439-931)	

ES-CE301	**Fluid Mechanics and Hydraulic Machines**	**2L + 1T**	**3 Credits**
Course Outcome	On successful completion of this course, student should be able to: 1. Define basic terms, values and laws in the areas of fluids properties, statics, kinematics and dynamics of fluids, and hydraulic design of pipe systems; 2. Describe methods of implementing fluid mechanics laws and phenomena while analyzing the operational parameters of hydraulic problems; 3. Practically apply tables and diagrams, and equations that define the associated laws; 4. Calculate and optimize operational parameters of hydraulic problems; 5. Explain the correlation between different operational parameters; 6. Select engineering approach to problem solving based on the acquired physics and mathematical knowledge.		
Prerequisite	Introduction to Civil Engineering, Physics.		
Module 1	**Properties of fluids** Fluid – definition, distinction between solid and fluid - Units and dimensions - Properties of fluids - density, specific weight, specific volume, specific gravity, viscosity, compressibility, vapour pressure, capillarity and surface tension.		**3L**
Module 2	**Fluid statics** Pressure at a point, basic equation for pressure field, pressure variation in a fluid at rest- incompressible fluid, compressible fluid, absolute pressure, gauge pressure; pressure measurements by manometers – general, inclined, inverted, micro-manometer; pressure and forces on submerged planes and curved surfaces, centre of pressure, buoyancy and floatation, Stability of submerged and floating bodies, Metacentric height.		**4L**
Module 3:	**Fluid Kinematics** The velocity field, Eulerian and Lagrangian flow descriptions, concepts of:- one-, two- and three-dimensional flows, steady and unsteady flows, streamlines, streaklines, pathlines; The acceleration field; Control volume and system representation, Continuity Equation, Momentum Equation, Moment-of-Momentum equation, applications to pipe bends; Types of motion: - Translation, deformation, rotation, vorticity.		**6L**
Module 4:	**Fluid Dynamics** Application of Newton's Law along a streamline, Bernoulli Equation, Kinetic energy head, potential energy head and pressure energy head, total energy head, Pitot tube, Examples of use of Bernoulli Equation, measurement of flows - venturimeter, energy line and hydraulic grade line, orifices and mouthpieces, discharge over rectangular, triangular, trapezoidal notches and weirs.		**7L**

Module 5:	**Dimensional Analysis** Buckingham Pi Theorem, determination of Pi terms, correlation of experimental data, examples, model analysis, similitude, dimensionless numbers, model laws, distorted and undistorted models.	**3L**
Module 6	**Flow through Pipes** Laminar flow, Reynolds number, critical velocity, turbulent flow, shear stress at pipe wall, velocity distribution, loss of head for laminar flow, Darcy-Weisbach Formula, head loss due to friction, minor head losses, flow through syphon, Concept of boundary layer and its growth.	**7L**
Module 7	**Pipeline Systems** Pipes in series, pipes in parallel, equivalent pipes, branching pipes, power transmission through pipes, flow through nozzles, water hammer, pipe networks: -Hardy Cross method	**7L**
Module 8	**Hydraulic Machines** Basics of hydraulic machines, specific speed of pumps and turbines.	**3L**

Reference

Sl. No.	**Book Name**	**Author**	**Publishing House**
1	A Textbook of Fluid Mechanics	R. K. Bansal	Laxmi Publications (P) Ltd., New Delhi.
2	Hydraulics & Fluid Mechanics Including Hydraulics Machines	P. N. Modi and S. M. Seth	Standard Book House, New Delhi, 2017.
3	Introduction to Fluid Mechanics and Fluid Machines	S. K. Som, G. Biswas and S. Chakraborty	Tata McGraw Hill Education Private Limited, New Delhi, 2012.
4	Fluid Mechanics	F. M. White	Tata McGraw Hill Education India Private Limited, 2017.
5	Fluid Mechanics and Hydraulic Machines	K. Subramanya	McGraw Hill Education (India)
6	Fluid Mechanics and Machinery	Ojha, Berndtsson and Chandramouli	Oxford University Press (India)

ES-CE302	ENGINEERING MECHANICS	3L + 0T	3 Credits
Module 1	**Introduction to Engineering Mechanics** Force Systems Basic concepts, Particle equilibrium in 2-D & 3-D; Rigid Body equilibrium; System of Forces, Coplanar Concurrent Forces, Components in Space – Resultant- Moment of Forces and its Application; Couples and Resultant of Force System, Equilibrium of System of Forces, Free body diagrams, Equations of Equilibrium of Coplanar Systems and Spatial Systems; Static Indeterminacy		**6L**
Module 2	**Friction** Types of friction, Limiting friction, Laws of Friction, Static and Dynamic Friction; Motion of Bodies, wedge friction, screw jack & differential screw jack;		**3L**
Module 3	**Basic Structural Analysis** Equilibrium in three dimensions; Method of Sections; Method of Joints; How to determine if a member is in tension or compression; Simple Trusses; Zero force members; Beams & types of beams;Frames & Machines;		**4L**
Module 4	**Centroid and Centre of Gravity** Centroid of simple figures from first principle, centroid of composite sections; Centre of Gravity and its implications; Area moment of inertia-Definition, Moment of inertia of plane sections from first principles, Theorems of moment of inertia, Moment of inertia of standard sections and composite sections; Mass moment inertia of circular plate, Cylinder, Cone, Sphere, Hook.		**5L**
Module 5	**Virtual Work and Energy Method** Virtual displacements, principle of virtual work for particle and ideal system of rigid bodies, degrees of freedom. Active force diagram, systems with friction, mechanical efficiency. Conservative forces and potential energy (elastic and gravitational), energy equation for equilibrium. Applications of energy method for equilibrium. Stability of equilibrium.		**4L**
Module 6	**Review of particle dynamics** Rectilinear motion; Plane curvilinear motion (rectangular, path, and polar coordinates). 3-D curvilinear motion; Relative and constrained motion; Newton's 2ndlaw (rectangular, path, and polar coordinates). Work-kinetic energy, power, potential energy. Impulse-momentum (linear, angular); Impact (Direct and oblique).		**4L**
Module 7	**Introduction to Kinetics of Rigid Bodies** Basic terms, general principles in dynamics; Types of motion, Instantaneous centre of rotation in plane motion and simple problems; D'Alembert's principle and its applications in plane motion and connected bodies; Work energy principle and its application in plane motion of connected bodies; Kinetics of rigid body rotation;		**5L**

Module 8	**Mechanical Vibrations** Basic terminology, free and forced vibrations, resonance and its effects; Degree of freedom; Derivation for frequency and amplitude of free vibrations without damping and single degree of freedom system, simple problems, types of pendulum, use of simple, compound and torsion pendulums;	**5L**
References	1. D.S. Bedi (2018), Engineering Mechanics, Khanna Publishing House, 2019 2. Irving H. Shames (2006), Engineering Mechanics, 4th Edition, Prentice Hall 3. F. P. Beer and E. R. Johnston (2011), Vector Mechanics for Engineers, Vol. I - Statics, Vol. II, –Dynamics, 9th Ed, Tata McGraw Hill 4. R.C. Hibbler (2006), Engineering Mechanics: Principles of Statics and Dynamics, Pearson Press. 5. Andy Ruina and Rudra Pratap (2011), Introduction to Statics and Dynamics, Oxford University Press 6. Shanes and Rao (2006), Engineering Mechanics, Pearson Education 7. Hibler and Gupta (2010), Engineering Mechanics (Statics, Dynamics) by Pearson Education 8. Reddy Vijay kumar K. and K. Suresh Kumar (2010), Singer's Engineering Mechanics 9. Bansal R.K.(2010), A Text Book of Engineering Mechanics, Laxmi Publications 10. Khurmi R.S. (2010), Engineering Mechanics, S. Chand & Co. 11. Tayal A.K. (2010), Engineering Mechanics, Umesh Publications	

PC-CE301	**SURVEYING & GEOMATICS**	**2L + 1T**	**3 Credits**
Course Outcome	Upon completing the course, the students will be able to: 1. Define and state the scope of surveying and geomatics in civil engineering 2. Understand the basic principles of surveying and geomatics engineering 3. Apply the different methods of surveying and geomatics to measure the features of interest 4. Analyse the traditional and advanced methods of surveying 5. Evaluate the different techniques of surveying and geomatics in solving real world problems. 6. Design and construct solutions for real world problems related to surveying and geomatics.		
Prerequisite	Knowledge of Mathematics and Physics in Class-XII		
Module 1	**Principles of Surveying:** Introduction, Principles and classification of surveying; Concept of scales; Survey stations and lines — ranging and bearing; Chain surveying — Concept, Instruments, numerical problems on errors due to incorrect chain; Plane table surveying — Advantages, disadvantages, parts, methods; Elements of simple and compound curves.		**4L+2T**
Module 2	**Levelling:** Levelling — Principles, Precautions and Difficulties; Differential levelling, - Concepts and numerical problems; Contouring.		**3L+1T**
Module 3	**Triangulation and Trilateration:** Theodolite survey — Instruments, measurements of horizontal and vertical angles; Triangulation — Network, signals, numerical examples; Baseline measurement — site selection, measuring equipment, numerical problems on baseline corrections; Trigonometric levelling — Axis signal correction.		**4L+2T**
Module 4	**Advanced Surveying:** Principle of Electronic Distance Measurement (EDM); Types of EDM instruments; Distomats; Total Station — Parts, advantages, applications, field procedure and errors; Global Positioning System (GPS) — Concept, applications, segments, location determination, errors; Principle of Differential GPS; Terrestrial laser scanner.		**3L+2T**
Module 5	**Photogrammetric Surveying:** Concept; Classification of photogrammetric surveying — terrestrial, aerial and satellite; scale of a vertical photograph; relief displacement and object height determination; Stereoscopic vision — depth perception, parallactic angle, stereoscopes; Object height determination using parallax; Parallax bar; Flight planning — Concept and numerical problems; Photo mosaic; Orthophotography; Stereoscopic plotting instruments.		**4L+2T**
Module 6	**Remote Sensing:** Energy sources and radiation principles; Concept of Electromagnetic Spectrum; Energy interactions in the atmosphere and earth surface features; Data acquisition and interpretation; Platforms and sensors — Geostationary and sun- synchronous orbits, push broom and whiskbroom scanning system, characteristics of IRS, Landsat and Sentinel sensors; Visual image interpretation.		**3L+2T**

PC-CE301	SURVEYING & GEOMATICS	2L + 1T	3 Credits
Module 7	**Digital Image Processing:** Concept; Image rectification and restoration; Image enhancement; Image classification; Accuracy assessment and post classification smoothing.		4L+2T
Module 8	**Applications of Geomatics in Civil Engineering:** 3D mapping; Earthquake and landslides; Runoff modelling; Groundwater targeting; Flood risk assessment; Urban planning; Highway and transportation.		3L + IT

Reference

Sl.	Book Name	Author	Publishing House
1	Surveying & Levelling	N. N. Basak	Mc Graw Hill Education (India) Private Limited
2	Surveying – Vol. I, II & III	B.C. Punmia Ashok Kumar Jain Arun Kumar Jain	Laxmi Publications (P) Ltd.
3	Surveying – Vol. I & II	S. K. Duggal	Mc Graw Hill Education (India) Private Limited
4	Surveying & Levelling – Part I & II	T. P. Kanetkar S. V. Kulkarni	Pune Vidyarthi Griha Prakashan
5	Remote Sensing and Image Interpretation	Thomas M. Lillesand Ralph W. Kiefer Jonathan W. Chipman	Wiley India Edition
6	Remote Sensing and GIS	Basudeb Bhatta	Oxford University Press
7	Principles of Geoinformatics	P.K. Garg	Khanna Publishing House
8	Applications of Geomatics in Civil Engineering	J. K. Ghosh I. de Silva (Eds.)	Springer

PC- CE302	ENGINEERING GEOLOGY	2L + 1T	3 Credits
Course Outcome	On successful completion of this course, student should be able: 1. To study and identify different types natural materials like rocks & minerals and soil. 2. To understand the various natural dynamic processes their influence on the surficial features, natural material and their consequences. 3. To know the physical properties of rocks & minerals. 4. To know the importance of geological maps and language helpful for Civil Engineering projects.		
Prerequisite	Knowledge of Geography of 10th standard		
Module 1	**Introduction:** Introduction and scope of Geology and subdivision, Internal structure of the earth, Weathering, erosion and denudations process on earth material and natural agencies, Geological work of wind, river underground water and glaciers. **Earthquakes:** Basics of earthquake, earthquake history, seismic activity, concept of intensity and magnitude of earthquake, causes of earthquake, influence on civil structures and engineering consideration, seismic zonation, Stratigraphy of INDIA-Introduction.		8L
Module 2	**Mineralogy and Petrology:** Study of physical properties of mineral and study of common rock forming minerals & way of formation of minerals, Study of three types of rocks with reference to their formation,identification, textural and structural features Rocks and natural materials asa construction material.		6L
Module 3	**Structural Geology:** Outcrop, stratification, dip and strike relation, Unconformity, joints their types and genesis Faults and folds with their types and causes, Engineering consideration of joints, folds and faults.		6L
Module 4	**Engineering Geology:** Basics of Engineering Geology, Importance of geological studies to Engineers and significance of geological Investigations for civil engineering projects, Geology for Site selection of Dam, Tunnel, Reservoir and Highways.		6L
Module 5	**Mass Movement:** Classification causes and effect of mass movements, stability of Slopes in unconsolidated materials, Influence of dip and slope Precautionary measures and control of mass movements, Case studies.		6L
Module 6	**Hydrogeology:** Ground water and occurrence, investigations, quality, artificial recharging.		4L

Reference	Sl.	Book Name	Author	Publishing House
	1	A text book of Geology	Mukharjee, P.K.	The World Press Pvt. Ltd.
	2	Textbook of Engineering Geology	Kesavulu, C.	World Scientific Publishing Company, 2018
	3	Principles of Engineering Geology	Bangar, K.M.	Standard Publishers Distributors, 1995, New Delhi
	4	Structural Geology	Billings, M.P.	Prentice-Hall India, 1974, New Delhi

PC- CE302	ENGINEERING GEOLOGY			2L + 1T	3 Credits
	5	M.H. Geology for Engineers	Blyth, F.G.H and de Freitas	1974 London	
	6	Experiments in Engineering Geology	Gokhale, KVG.K and Rao, D.M.	Tata-McGraw Hill, 1981, New Delhi	
	7	V. Engineering Geology for Civil Engineers	Reddy, V.	Oxford & IBH, 1997, New Delhi	
	8	Groundwater Hydrology	Todd, D.K.	1980, New York	

List of the experiments to be conducted along with the theoretical classes (as Tutorial classes)

Experiment No.	Name of Experiment
1	Fundamental of Geology
2	Study of Physical Properties of Minerals
3	Identification of Minerals and Rock sample
4	Megascopic Study of Rock Forming Minerals (Hand Specimen Study)
5	Megascopic Study of Igneous Rocks
6	Megascopic Study of Sedimentary Rocks
7	Megascopic Study of Metamorphic Rocks
8	Introduction to Geological Maps for different structural features, Presentation of Beds Along Section and Construction of Geological History

MC-CE301	**ENERGY & ENVIRONMENTAL SCIENCE**	**2L**	**0 Credits**
Course Outcome	On successful completion of this course, student should be able to: 1. Gain knowledge about environment and ecosystem. 2. Learn about natural resource, its importance and environmental impacts of human activities on natural resource. 3. Gain knowledge about the conservation of biodiversity and its importance. 4. Be aware about problems of environmental pollution, its impact on human and ecosystem and control measures. 5. Learn about increase in population growth and its impact on environment		
Prerequisite	Knowledge of Biology in XII standard		
Module 1	**Introduction to Energy Science:** Introduction to energy systems and resources; Introduction to Energy, sustainability & the environment; Overview of energy systems, sources, transformations, efficiency, and storage; Fossil fuels (coal, oil, oil-bearing shale and sands, coal gasification) – past, present & future, Remedies & alternatives for fossil fuels – biomass, wind, solar, nuclear, wave, tidal and hydrogen; Sustainability and environmental trade-offs of different energy systems; possibilities for energy storage or regeneration (Ex. Pumped storage hydro power projects, superconductor-based energy storages, high efficiency batteries).		**4L**
Module 2	**Ecosystems:** Concept of an ecosystem; Structure and function of an ecosystem; Producers, consumers and decomposers; Energy flow in the ecosystem; Ecological succession; Food chains, food webs and ecological pyramids; Introduction, types, characteristic features, structure and function of the following ecosystem (a.) Forest ecosystem (b) Grassland ecosystem (c) Desert ecosystem (d) Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)		**3L**
Module 3	**Biodiversity and its conservation:** Introduction – Definition: genetic, species and ecosystem diversity; Bio-geographical classification of India; Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values; Biodiversity at global, National and local levels; India as a mega-diversity nation; Hot-sports of biodiversity; Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts; Endangered and endemic species of India; Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.		**3L**
Module 4	**Environmental Pollution:** Definition, Cause, effects and control measures of Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards; Solid waste Management: Causes, effects and control measures of urban and industrial wastes; Role of an individual in prevention of pollution; Pollution case studies; Disaster management: floods, earthquake, cyclone and landslides.		**3L**

<table>
<tr><td>MC-CE301</td><td colspan="3">ENERGY & ENVIRONMENTAL SCIENCE</td><td>2L</td><td>0 Credits</td></tr>
<tr><td>Module 5</td><td colspan="4">Social Issues and the Environment:
From Unsustainable to Sustainable development; Urban problems related to energy; Water conservation, rain water harvesting, watershed management; Resettlement and rehabilitation of people; its problems and concerns. Case Studies Environmental ethics: Issues and possible solutions. Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case Studies Wasteland reclamation; Consumerism and waste products; Environment Protection Act; Air (Prevention and Control of Pollution) Act; Water (Prevention and control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act; Issues involved in enforcement of environmental legislation; Public awareness.</td><td>3L</td></tr>
<tr><td>Module 6</td><td colspan="4">Field work
• Visit to a local area to document environmental assets river /forest/grassland/hill/mountain
• Visit to a local polluted site-Urban/Rural/Industrial/Agricultural
• Study of common plants, insects, birds.
• Study of simple ecosystems-pond, river, hill slopes, etc.</td><td>4T</td></tr>
<tr><td rowspan="6">Reference</td><td>Sl.</td><td>Book Name</td><td>Author</td><td colspan="2">Publishing House</td></tr>
<tr><td>1</td><td>1989, Hazardous Waste Incineration</td><td>Brunner R.C.,</td><td colspan="2">McGraw Hill Inc.</td></tr>
<tr><td>2</td><td>Environmental Encyclopedia</td><td>Cunningham, W.P. Cooper, T.H. Gorhani, E & Hepworth, M.T.</td><td colspan="2">Jaico Publ. House, Mumabai, 2001</td></tr>
<tr><td>3</td><td>Energy Systems and Sustainability: Power for a Sustainable Future</td><td>Boyle, Godfrey, Bob Everett, and Janet Ramage (Eds.) (2004)</td><td colspan="2">Oxford University Press.</td></tr>
<tr><td>4</td><td>Real Goods Solar Living Sourcebook: The Complete Guide to Renewable Energy Technologies and Sustainable Living</td><td>Schaeffer, John (2007)</td><td colspan="2">Gaiam</td></tr>
<tr><td>5</td><td>Environmental Chemistry</td><td>De A.K.</td><td colspan="2">Wiley Eastern Ltd.</td></tr>
</table>

ES-CE391	**Fluid Mechanics and Hydraulic Machines Laboratory**	**2P**	**1 Credits**
Course Outcome	On completion of the course, the students will be able to: 1. Calibrate the notch and orifice meter. 2. Evaluate the performance of pump and turbine. 3. Determine the various hydraulic coefficients. 4. Determine the minor losses through pipes. 5. Measure the water surface profile due to formation of hydraulic jump. 6. Measure the water surface profile for flow over Broad crested weir.		
Prerequisite	Introduction to Fluid Mechanics & Hydraulic Machines [ES-CE301]		
Experiment 1	Calibration of Notches		
Experiment 2	Calibration of Orifice meter		
Experiment 3	Determination of Hydraulic Coefficient of an Orifice		
Experiment 4	Performance Test on Centrifugal Pump		
Experiment 5	Performance Test on Reciprocating Pump		
Experiment 6	Determination of Minor Losses in Pipes due to Sudden Enlargement and Sudden Contraction		
Experiment 7	Velocity measurement through Pitot Tube		
Experiment 8	Measurement of water surface profile for flow over Broad crested weir		
Experiment 9	Measurement of water surface profile for a hydraulic jump		
Experiment 10	Measurement of coefficient of friction in pipe flow		
Experiment 11	Performance Test on Pelton Wheel Turbine		

ES-CE392	**COMPUTER-AIDED CIVIL ENGINEERING DRAWING**	**3P**	**1.5 Credits**
Module 1	**INTRODUCTION** Introduction to concept of drawings, Interpretation of typical drawings, Planning drawings to show information concisely and comprehensively; optimal layout of drawings and Scales; Introduction to computer aided drawing, co-ordinate systems, reference planes. Commands: Initial settings, Drawing aids, Drawing basic entities, Modify commands, Layers, Text and Dimensioning, Blocks. Drawing presentation norms and standards.		**2 L**
Module 2	**SYMBOLS AND SIGN CONVENTIONS** Materials, Architectural, Structural, Electrical and Plumbing symbols. Rebar drawings and structural steel fabrication and connections drawing symbols, welding symbols; dimensioning standards		**2 L**
Module 3	**MASONRY BONDS** English Bond and Flemish Bond – Corner wall and Cross walls -One brick wall and one and half brick wall.		**1 L**
Module 4	**BUILDING DRAWING** Terms, Elements of planning building drawing, Methods of making line drawing and detailed drawing. Site plan, floor plan, elevation and section drawing of small residential buildings. Foundation plan. Roof drainage plans. Depicting joinery, standard fittings & fixtures, finishes. Use of Notes to improve clarity.		**5 L**
Module 5	**PICTORIAL VIEW** Principles of isometrics and perspective drawing. Perspective view of building. Fundamentals of Building Information Modelling (BIM).		**2 L**
Drawings			
1	Buildings with load bearing walls including details of doors and windows.		**6P**
2	Taking standard drawings of a typical two storeyed building including all MEP, joinery, rebars, finishing and other details and writing out a description of the Facility in about 500-700 words.		**4P**
3	RCC framed structures		**6P**
4	Reinforcement drawings for typical slabs, beams, columns and spread footings		**6P**
5	Industrial buildings - North light roof structures – Trusses		**4P**
6	Perspective view of one and two storey buildings		**4P**
Reference	1. Subhash C Sharma & Gurucharan Singh (2005), "Civil Engineering Drawing", Standard Publishers 2. Pradeep Jain & A.P. Gautam, Engineering Graphics & Design, Khanna Publishing House (2019) 3. Ajeet Singh (2002), "Working with AUTOCAD 2000 with updates on AUTOCAD 200I", Tata- Mc Graw-Hill Company Limited, New Delhi 4. Sham Tickoo Swapna D (2009), "AUTOCAD for Engineers and Designers", Pearson Education, 5. Venugopal (2007), "Engineering Drawing and Graphics + AUTOCAD", New Age International Pvt. Ltd. 6. Shah, Engineering Drawings and Computers, Pearson 7. Balagopal and Prabhu (1987), "Building Drawing and Detailing", Spades publishing KDR building, Calicut.		

PC-CE391	SURVEYING & GEOMATICS LABORATORY	3P	1.5 Credits
Course Outcome	Upon completion of the course, the students will be able to: 1. State the interdependency and advancement of different surveying methods 2. Comprehend the working principles of different surveying and geomatics instruments and experiments 3. Execute the different methods of surveying and geomatics to measure the features of interest 4. Examine the results obtained from the surveying and geomatics experiments 5. Critically appraise the different techniques of surveying and geomatics in measuring and assessing the features of interest 6. Design and construct solutions for real world problems related to surveying and geomatics.		
Prerequisite	Surveying & Geomatics [PC-CE301]		
Experiment 1	Traverse survey by Prismatic Compass: Procedure; Computation and checks on closed traverse; Preparation of field book; Plotting the traverse; Sources of errors.		
Experiment 2	Theodolite Survey: Closed traverse by transit theodolite, Preparation of field book		
Experiment 3	Differential Levelling using Dumpy level: Collimation and Rise and Fall methods, Field book preparation		
Experiment 4	Total Station Survey: Traversing and Levelling		
Experiment 5	Visual Image Interpretation		
Experiment 6	Satellite Image Pre-processing		
Experiment 7	Digital Image Classification and Accuracy Assessment		
Experiment 8	Stereoscopic fusion of aerial photographs using mirror stereoscope		

HU-CE401	VALUE & ETHICS IN PROFESSION	2L + 0T	2 Credits
Course Outcome	**After going through this course, the students will be able to:** 1. Understand basic purpose of profession, professional ethics and various moral and social issues. 2. Awareness of professional rights and responsibilities of an Engineer, safety and risk benefit analysis of an Engineer 3. Acquiring knowledge of various roles of Engineer in applying ethical principles at various professional levels 4. Professional Ethical values and contemporary issues 5. Excelling in competitive and challenging environment to contribute to industrial growth.		
Prerequisite	Science, Technology and Engineering as knowledge and as Social and Professional Activities.		
Module 1	**Effects of Technological Growth:** Rapid Technological growth and depletion of resources, Reports of the Club of Rome. Limits of growth: sustainable development, Energy Crisis: Renewable Energy Resources, Environmental degradation and pollution. Eco-friendly Technologies. Environmental Regulations, Environmental Ethics.		4L
Module 2	**Appropriate Technology Movement of Schumacher**; later developments Technology and developing notions. Problems of Technology transfer, Technology assessment impact analysis. Human Operator in Engineering projects and industries. Problems of man, machine, interaction, Impact of assembly line and automation. Human cantered Technology.		4L
Module 3	**Ethics of Profession:** Engineering profession: Ethical issues in Engineering practice, Conflicts between business demands and professional ideals. Social and ethical responsibilities of Technologists. Codes of professional ethics. Whistle blowing and beyond, Case studies.		4L
Module 4	**Profession and Human Values:** Values Crisis in contemporary society Nature of values: Value Spectrum of a good life Psychological values: Integrated personality; mental health		4L
Module 5	**Societal values:** The modern search for a good society, justice, democracy, secularism, rule of law, values in Indian Constitution.		2L
Module 6	**Aesthetic values:** Perception and enjoyment of beauty, simplicity, clarity Moral and ethical values: Nature of moral judgements; canons of ethics; ethics of virtue; ethics of duty; ethics of responsibility		4L
Reference	1. Stephen H Unger, Controlling Technology: Ethics and the Responsible Engineers, John Wiley & Sons, New York 1994 (2nd Ed) 2. Deborah Johnson, Ethical Issues in Engineering, Prentice Hall, Englewood Cliffs, New Jersey 1991. 3. A.N. Tripathi, Human values in the Engineering Profession, Monograph published by IIM, Calcutta 1996.		

4. Professional Ethics: R. Subramanian, Oxford University Press, 2015.
5. Ethics in Engineering Practice & Research, Caroline Whitbeck, 2e, Cambridge University Press 2015.
6. Engineering Ethics, Concepts Cases: Charles E Harris Jr., Michael S Pritchard, Michael J Rabins, 4e , Cengage learning, 2015.
7. Business Ethics concepts & Cases: Manuel G Velasquez, 6e, PHI, 2008.

CE(ES)401	SOLID MECHANICS	2L + 1T	3 Credits
Course Outcome	After going through this course, the students will be able to: 1. To identify the equilibrium conditions and elastic properties of axially loaded bars through stress-strain and force-displacement curves. 2. To identify the principal plane and principal stresses throughMohr circle. 3. To calculate the hoop and meridional stresses in thin cylinders and spherical shells. 4. To identify different degrees of freedoms for support conditions like hinge, roller and fixedconstraints. 5. To calculate the bending moment, shear force and deflection of beams for uniformly distributed, concentrated, linearly varying and external concentrated moment. 6. To calculate the member forces in a plane truss using Method of Joint and Method of Section. 7. To identify torsional moment and twist on a circular shaft and calculate the shear stress. 8. To know the concepts of strain energy due to axial load, bending and shear. 9. To calculate the buckling load of columns using Euler's theory for different support constraints		
Prerequisite	Engineering Mechanics [ES-CE302], Basic Calculus		
Module 1	**Review of Basic Concepts of Stress and Strain:** Normal stress, Shear stress, Bearing stress, Normal strain, Shearing strain; Hooke's law; Poisson's ratio; Stress-strain diagram of ductile and brittle materials; Elastic limit; Ultimate stress; Yielding; Modulus of elasticity; Factor of safety, Beam Statics: Support reactions, concepts of redundancy, axial force, shear force and bending moment diagrams for concentrated, uniformly distributed, linearly varying load, concentrated moments insimply supported beams, cantilever and overhanging beams		**6L**
Module 2	**Symmetric Beam Bending**: Basic kinematic assumption, moment of inertia, elastic flexure formulae and its application, Bending and shear stress for regular sections, shear centre		**3L**
Module 3	**Deflection of statically determinate beams**: Fundamental concepts: Elastic curve, moment Curvature relationship, governing differential equation, boundary conditions: Direct integration solution		**4L**
Module 4	**Analysis of determinate plane trusses**: Concepts of redundancy, Analysis by method of joints, method of sections		**4L**

Module 5	**Two Dimensional Stress Problems**: Principal stresses, maximum shear stresses, Mohr's circle of stresses, construction of Mohr's circle	**3L**
Module 6	**Introduction to thin cylindrical & spherical shells**: Hoop stress and meridional - stress and volumetric changes	**3L**
Module 7	**Torsion**: Pure torsion, torsion of circular solid shaft and hollow shafts, torsional equation, torsional rigidity, closed coil helical; springs	**4L**
Module 8	**Columns:** Fundamentals, criteria for stability in equilibrium, column buckling theory, Euler's load for columns with different end conditions, limitations of Euler's theory – problems, eccentric load and secant formulae.	**3L**

Reference

Sl.	**Book Name**	**Author**	**Publishing House**
1	Elements of Strength of Material	S. P. Timoshenko and D. H. Young	EWP Pvt. Ltd
2	Mechanics of Material	R.C. Hibbeler	Pearson
3	Mechanics of Material	Beer, Jhonston, DeWolf, Mazurek	McGrawHill Education
4	Strength of Materials	R. Subramanian	OXFORD University Press
5	Strength of Materials	S S Bhavikatti	Vikas Publishing House Ltd
6	Strength of Materials	R.K. Bansal	Laxmi Publication
7	Fundamentals of Strength of Material	Nag & Chandra	WIE

PC-CE401	**CONCRETE TECHNOLGY & CONSTRUCTION MATERIALS**	**3L + 0T**	**3 Credits**
Course Outcome	**After going through this course, the students will be able to:** 1. Test all the required properties of concrete and construction materials as per IS code. 2. Compute the properties construction materials and concrete at fresh and hardened state. 3. Design the concrete mix as per latest IS code methods. 4. Ensure quality control while testing/ sampling. 5. Design the special type of concrete for specific application purposes. 6. Use the admixture as per requirement.		
Prerequisite	Undergraduate level Engineering Chemistry		
Module 1	**Cement:** Manufacturing of cement, Oxides composition of cement and the calculation of compounds, Heat of hydration, Types of cement- OPC, RPC. Low heat cement, PPC, PSC, Sulphate resisting cement, High Alumina cement, Expansive cement, White cement; Test on cement- fineness, consistency, initial setting time & final setting time, soundness test, strength test, specific gravity of cement, storage of cement. **Lime:** Impurities in limestone, Classification, Slaking and hydration, Hardening, Testing, Storage, Handling		**4L**
Module 2	**Aggregates:** Classification, Grading, alkali-aggregate reaction, deleterious substances in aggregates, physical properties, testing of aggregates- fineness modulus, bulking, specific gravity, sieve analysis, flakiness & elongation index. Quality of Water for mixing and curing - use of sea water for mixing concrete. **Mortars:** Classification, Uses, Characteristics of good mortar, Ingredients. Cement mortar, Lime mortar, Lime cement mortar, special mortars		**3L**
Module 3	**Properties of fresh concrete:** Workability, factors affecting workability, segregation and bleeding, tests on workability- slump test, compacting factor test, vee-bee test, and flow table test. **Properties of Hardened concrete:** Tensile & compressive strength, flexural strength, stress-strain characteristics, modulus of elasticity, poisson's ratio, Creep, shrinkage, permeability of concrete, micro cracking of concrete. **Strength of concrete:** curing methods, water-cement ratio. gel-space ratio, maturity of concrete,		**6L**
Module 4	**Admixtures:** types, uses, super plasticizers, plasticizers, and Bonding admixtures. **Mix Design** – Objective, factors influencing mix proportion - Mix design by I.S. 10262-2019. (with & without admixture) **Special Concrete** – Ferro cement - Fibre reinforced concrete - Polymer concrete - Sulphur Concrete - Self compacting concrete. Ready mix		**6L**

	concrete, Batching plant. **Non-destructive test:** Rebound hammer and Ultra-sonic pulse velocity testing methods. Quality control - Sampling and testing, Acceptance criteria.	
Module 5	**Bricks:** Classification, Characteristics of good bricks, ingredients of good brick earth, Harmful substance in brick Earth, Different forms of bricks, Testing of bricks as per BIS. Defects of bricks. Brick masonry: Definitions, Rules for bonding, Type of bonds – stretcher bond, Header bond, English bond, Flemish Bond, Comparison of English Bond and Flemish Bond (one and one and half brick thick wall) **Foundations:** Function of Foundations, Essential requirement of good foundation, Different types of shallow and deep Foundations	**7L**
Module 6	Wood and Wood Products: Wall, Doors and Windows: Paints, Enamels and Varnishes: Stairs: Flooring: Plastering and Pointing: Roofs:	**4L**
Reference	1. Concrete Technology (Theory & Practice) by Shetty, M.S., S. Chand and Co. 2. Concrete Technology, Gambhir, M.L., Tata McGraw Hill 3. Concrete Technology, A. M. Nevillie and J.J. Brooks Pearson, Education India Ltd. 4. Properties of Concrete, A.M.Neville, Pearson India 5. Building Materials by Rangawala 6. Building Materials and Construction by B. C. Punmia 7. Building Construction and Foundation Engineering by Jha and Sinha 8. Building Materials by S. K. Duggal 9. Building Materials by P.C. Varghese, PHI	

PC-CE402	ENGINEERING HYDROLOGY	3L + 0T	3 Credits
Course Outcome	**On completion of the course, the students will be able to:** 1. Study the source, occurrence, movement and distribution of water which is a prime resource for development of a nation. 2. Learn about the functioning of reservoirs and estimation of storage capacities. 3. Learn about flood hazards, estimation of design floods for various structures and methods of estimating effects of passageof floods through rivers and reservoirs. 4. Know the basic principles of measurement of flow in rivers.		
Prerequisite	ES-CE301, Fluid Mechanics, Chemistry BS-CH101, Physics BS-CH201.		
Module 1	**Hydrology:** Hydrologic Cycle, Global Water Budget, India's Water Budget.		**1L**
Module 2	**Catchment:** Definition & Descriptions, Various Types of Catchment, Factors Characterizing a Catchment, Delineation of Catchment Boundary.		**2L**
Module 3:	**Measurement of Precipitation:** Precipitation, Description and Functioning of Various Types of Rain gauges, Rain gauge Network- Codal Provisions, Optimum Number of Raingauge Stations.		**2L**
Module 4:	**Processing of Rainfall Data:** Normal Rainfall, Estimation of Missing Rainfall Data, Test for Consistency of Record; Mass Curve of Rainfall, Hyetograph, Point Rainfall; Mean Precipitation overan Area– Arithmetic Mean, Thiessen Polygon and Isohyetal Method.		**4L**
Module 5:	**Losses from Precipitation:** Evaporation – Evaporation Process, Factors affecting Evaporation, Measurement of Evaporation– Description and Functioning of Pan Evaporimeter, Pan Coefficient, Evapotranspiration: AET, PET, Measurement of ET, Estimation of ET– Blaney-Criddle Formulae; Infiltration– Process, Factors Affecting Infiltration, Infiltration Rate and Infiltration Capacity, Measurement of Infiltration, Infiltration Equations, Infiltration Indices.		**6L**
Module 6	**Streamflow Measurement:** Importance, Direct and Indirect Methods, Measurement of Stage– Various Gauges and Recorders, Measurement of Velocity– Current Meters, their Functioning and Calibration; Velocity Distribution, Floats; Streamflow Computation– Area-Velocity Method, Moving Boat Method, Dilution Technique, Electromagnetic Method, Ultrasonic Method; Indirect Methods– Flow Measuring Structures, Slope Area Method; Stage- Discharge Relation, Permanent Control, Stage for ZeroDischarge, Shifting Control– Backwater Effect, Unsteady Flow Effect, Extension of the Rating Curve.		**12L**

Module 7	**Runoff:** Description of the Process, Components of Runoff, Factors Affecting Runoff, Characteristics of Streams, Rainfall Runoff Relationships.	**2L**
Module 8	**Hydrographs:** Types, Base Flow Separation, Effective Rainfall. Unit Hydrograph– Definition, Assumptions, Applications– Derivation of Unit Hydrograph, Distribution Graph, Unit Hydrograph of Different Durations– Method of Superposition and S- Curve, synthetic unit hydrograph, instantaneous unit hydrograph	**4L**
Module 9	**Floods:** Concept of flood as a natural hazard; Estimation of flood discharge in a river – rational method, empirical formulae, unit hydrograph method; floodfrequency studies – return period.	**2L**
Module 10	**Flood Routing:** Concept of flood routing in channels and through a reservoir, basic routing equations; reservoir routing – Modified Pul's method; channel routing – Muskingum method.	**5L**

	Sl.	**Book Name**	**Author**	**Publishing House**
Reference	1	Engineering Hydrology (4th Ed.	K. Subramanya	McGraw Hill Education (India) Private Limited, New Delhi, 2013.
	2	Engineering Hydrology	R. Srivastava and A. Jain	McGraw Hill Education (India) Private Limited, New Delhi, 2017.
	3	Applied Hydrology	V. T. Chow, D.Maidment, L. Mays	Tata McGraw Hill Edition, New Delhi, 2010.

PC-CE403	**SOIL MECHANICS I**	**3L + 0T**	**3 Credits**
Course Outcome	After going through this course, the students will be able to: 1. Classify soil as per grain size distribution curve and understand the index properties of soil. 2. Apply the concept of total stress, effective stress and pore water pressure for solving geotechnical problems. 3. Assess the permeability of different types of soil and solve flow problems. 4. Estimate the seepage loss, factor of safety against piping failure using flow net related to any hydraulic structure. 5. Determine vertical stress on a horizontal plane within a soil mass subjected to different types of loading on the ground surface and also the maximum stressed zone or isobar below a loaded area.		
Prerequisite	Undergraduate level knowledge of Engineering Mechanics.		
Module 1	**Origin & formation of Soil:** Principal types of soil, Typical Indian Soil, size and shape of soil particles, Properties of very fine soil fraction, structure of clay.		**4L**
Module 2	**Soil Aggregate:** Texture, Structure and consistency, soil as a three phase system, Weight- Volume Relationship, Measurement of Physical Properties of Soil: In-situ Density, Moisture Content, Specific Gravity, and Relative Density.		**5L**
Module 3	**Particle Size Distribution:** By Sieving, Sedimentation Analysis.		**4L**
Module 4	**Index Properties of Soil:** Consistency of undisturbed soil and remoulded soil, Attarberg's Limits- Determination of Index Properties of Soil by Casagrande's Apparatus, Cone Penetrometer, Soil Indices, and importance of index properties.		**4L**
Module 5	**Soil Classification:**As per Unified Classification System, As per IS Code Recommendation, AASHTO Classification, Field Identification of Soil		**4L**
Module 6	**Soil Moisture:** Permeability, Capillarity in Soil, Darcy's Law, Determination of Coefficient of Permeability of Soil in Laboratory & in Field, Permeability for Stratified Deposits.		**5L**
Module 7	**Two Dimensional Flow Through Soil:** Laplace's Equations, Flow nets, Flow Through Earthen Dam, Estimation of Seepage, Seepage pressure, Design of Fillers.		**5L**
Module 8	**Concept of Effective Stress:** Definition of Effective Stress and neutral stress, Estimation of Effective stress, Critical Hydraulic Gradient, Quick Sand Condition.		**3L**
Module 9	**Vertical Stress in soil beneath a loaded area:** Bousinesq's Equations, stress distribution due to point load, line load, strip load, uniformly loaded area, circular, rectangular, Pressure Bulbs, Influence chart for vertical		**8L**

	pressure due to Newmark, 1942, Westergaad's equation, Simplified approach to determine load distribution	
Module 10	**Introduction to Rocks:** Rock Mechanics, Rock Materials, Rock Formations, Types of rock, Geological structures and discontinuities, weathering of rocks and soil formation.	**8L**
Reference	1. An Introduction to Geotechnical engineering – Holtz and Kovacs, Prentice Hall 2. Principles of Geotechnical Engineering – BM Das, Thomson 3. Principles of Soil Mechanics & Foundation Engineering by V.N.S. Murthy (UBS Publishers). 4. Soil Mechanics & Foundation Engineering by B.C.Punmia (Laxmi Publications). 5. Introduction of Soil Mechanics by B.M.Das (Galgotia Publications). 6. Soil Mechanics by – T.W.Lambe & R.V.Whitman. 7. SP-36 (Part – I & Part - II). 8. Basic & Applied Soil Mechanics by- Gopal (Ranjan & A.S.R.Rao (Willes Eastern Ltd.) 9. SOIL MECHANICS AND FOUNDATIONS – Muni Budhu; JOHN WILEY &SONS, INC	

PC-CE404	ENVIRONMENTAL ENGINEERING I	3L + 0T	3 Credits
Course Outcome	**After going through this course, the students will be able to:** 1. Define the basic concepts and terminologies of water supply engineering and solid waste management 2. Describe different surface and groundwater sources 3. Apply the methods of quantifying water requirement 4. Solve different mathematical problems regarding different components of water supply systems, distribution networks 5. Compare between different water samples based on their physical, chemical and biological characteristics 6. Design different unit processes and operations involved in water treatment		
Prerequisite	Class-XII level knowledge of Physics, Chemistry, Mathematics, Biology and Environmental Science; Undergraduate level knowledge of Engineering Statistics, Engineering Physics, Engineering Chemistry, Fluid Mechanics and Hydraulics and Environmental Engineering		
Module 1	**Water Requirement Estimation- Water Demand:** Different types of water demand; Per capita demand; Variations in demand; Factors affecting water demand; Future Demand Forecasting: Design period; Population forecasting methods		**3L**
Module 2	**Sources of Water:** Surface Water Sources; Ground Water Sources		**2L**
Module 3	**Water Quality:** Structure and Properties of Water; Water- a polar solvent ; Water Quality Characteristics: Physical, Chemical, and Biological parameters; Methods for expressing concentration and inter-conversion of it; Law of Electro-neutrality and its applications; Various equilibrium constants; Determination of concentrations of dissolved constituents including pH; Drinking Water Standards: BIS; WHO; USEPA Water Quality Indices: Basic concept and example		**6L**
Module 4	**Collection and conveyance of water:** Intakes-river, lake, reservoir and canal; Hydraulic design of pressure pipes; Hydrostatic tests on pipes		**4L**
Module 5	**Water Treatment:** Typical flow chart for surface and groundwater treatments; Unit Operation and Processes: Aeration, Plain Sedimentation, Sedimentation with Coagulation and Flocculation, Water Softening, Filtration, Disinfection		**9L**
Module 6	**Water Distribution**: Systems of distribution, layout of distribution system, Pressure in distribution system, Storage and distribution reservoirs. Capacity of reservoirs. Type of reservoirs. Analysis of distribution network Detection and presentation of leakages.		**4L**

	Sl.	Book Name	Author	Publishing House
Reference	1	Environmental Engineering	Peavy, Rowe and Tchobanoglous	Tata McGraw Hill Indian Edition
	2	Theory and Practices for Water and Wastewater Treatment	Ronald L Drsote	Wiley Publishers
	3	Manual of Water Supply & Treatment		A Government of India Publication.
	4	Environmental Engineering. Volume-1	S.K. Garg	Khanna Publishers
	5	Water Quality and Treatment: A Handbook of Community Water supplies		American Water Works Association
	6	Water Quality and Treatment	S.C. Sharma	Khanna Publishing House

MC-CE401	ESSENCE OF TRADITIONAL KNOWLEDGE	2L + 0T	0 Credits
Course Outcome	**After going through this course, the students will be able to:** 1. Understand the concept of Traditional knowledge and its importance 2. Know the need and importance of protecting traditional knowledge. 3. Know the various enactments related to the protection of traditional knowledge. 4. 4. Understand the concepts of Intellectual property to protect the traditional knowledge.		
Module 1	**Introduction to traditional knowledge:** Define traditional knowledge, nature and characteristics, scope and importance, kinds of traditional knowledge, the physical and social contexts in which traditional knowledge develop, the historical impact of social change on traditional knowledge systems. Indigenous Knowledge (IK), characteristics, traditional knowledge vis-a-vis indigenous knowledge, traditional knowledge Vs. western knowledge, traditional knowledge vis-à-vis formal knowledge		**5L**
Module 2	**Protection of traditional knowledge (TK):** the need for protecting traditional knowledge Significance of TK Protection, value of TK in global economy, Role of Government to harness TK.		**4L**
Module 3	**Legal frame work and TK:** A: The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006, Plant Varieties Protection and Farmer's Rights Act, 2001 (PPVFR Act); B: The Biological Diversity Act 2002 and Rules 2004, the protection of traditional knowledge bill, 2016. Geographical indicators act 2003.		**5L**
Module 4	**Traditional knowledge and intellectual property:** Systems of traditional knowledge protection, Legal concepts for the protection of traditional knowledge, Certain non IPR mechanisms of traditional knowledge protection, Patents and traditional knowledge, Strategies to increase protection of traditional knowledge, global legal FORA for increasing protection of Indian Traditional Knowledge.		**5L**
Module 5	**Traditional knowledge in different sectors:** Traditional knowledge and engineering, Traditional medicine system, TK and biotechnology, TK in agriculture, Traditional societies depend on it for their food and healthcare needs, Importance of conservation and sustainable development of environment, Management of biodiversity, Food security of the country and protection of TK.		**5L**
Reference	1. A. Jha, Traditional Knowledge System in India, 2009. 2. B.K. Mohanta and V.K. Singh, Traditional Knowledge System and Technology in India,Pratibha Prakashan, 2012. 3. K. Kapoor and M. Danino, Knowledge Traditions and Practices of India, Central Board ofSecondary Education, 2012. 4. E-Resources: http://nptel.ac.in/courses/121106003/		

ES-CE491	SOLID MECHANICS LABORATORY	2P	1 Credits
Course Outcome	**After going through this course, the students will be able to:** 1. Demonstrate the method and findings of tension and compression tests on ductile andbrittle materials. 2. Explain the method of bending tests on mild steel beam and concrete beam. 3. Demonstrate the method and findings of Torsion test on mild steel circular bar andconcrete beam. 4. Illustrate the concept of hardness and explain the procedure and findings of Brinneland Rockwell tests. 5. Demonstrate the concept and procedure of calculation of spring constant and elaborateits use in Civil Engineering. 6. Demonstrate the method and findings of Izod and Charpy impact tests. 7. Understand the concepts of fatigue test.		
Prerequisite	Solid Mechanics [ES-CE401]		
Experiment 1	Tension test on Structural Materials: Mild Steel and Tor steel (HYSD bars)		
Experiment 2	Compression Test on Structural Materials: Timber, bricks and concrete cubes		
Experiment 3	Bending Test on Mild Steel		
Experiment 4	Torsion Test on Mild Steel Circular Bar		
Experiment 5	Hardness Tests on Ferrous and Non-Ferrous Metals: Brinnel and Rockwell Tests		
Experiment 6	Test on closely coiled helical spring		
Experiment 7	Impact Test: Izod and Charpy		
Experiment 8	Demonstration of Fatigue Test		

PC-CE491	CONCRETE TECHNOLOGY LABORATORY	2P	1 Credits
Course Outcome	**Upon completion of the course, the students will be able to:** 1. Demonstrate the method and findings of tension and compression tests on concrete. 2. Understand the concepts of different test on hardened concrete. 3. Find out the mix proportion of high grade of concrete. 4. Measure the workability of concrete mix. 5. Know about the quality of concrete.		
Prerequisite	Concrete Technology & Construction materials [PC-CE401]		
Experiment 1	Tests on Fresh Concrete: Workability : Slump, Vee-Bee, Compaction factor tests		
Experiment 2	Hardened Concrete: Compressive strength on Cubes, Split tensile strength, Static modulus of elasticity, Flexure tests , Non-destructive testing (Rebound hammer & Ultrasonic pulse velocity)		
Experiment 3	Mix Design of Concrete.		

PC-CE492	CONSTRUCTION MATERIAL LABORATORY	2P	1 Credits
Course Outcome	**Upon completion of the course, the students will be able to:** 1. Calculate the specific gravity of concrete ingredients. 2. Understand the different properties of cement. 3. Know about the quality of concrete.		
Prerequisite	Concrete Technology & Construction materials [PC-CE401]		
Test on Fine aggregates	Bulking, Specific gravity, Bulk Density, Percentage voids, Fineness Modulus. Grading curve.		
Test on Coarse aggregates	Specific gravity, Bulk Density, Percentage voids, Fineness Modulus. Grading curve.		
Test on Cement	Normal consistency, fineness, Initial setting and final setting time of cement. Specific gravity, soundness and Compressive strength of Cement.		
Tests on bricks and tiles (Roofing and Flooring)	Water absorption, breaking loads.		

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PC-CE493	SOIL MECHANICS- I LABORATORY	2P	1 Credits
Course Outcome	After going through this course, the students will be able to: 1. Identify different types of soil by visual inspection. 2. Determine natural moisture content and specific gravity of various types of soil. 3. Estimate in-situ density by core cutter method and sand replacement method. 4. Analyze grain size distribution and Atterberg limits for soil. 5. Perform laboratory tests to determine permeability and compaction characteristics of soil.		
Prerequisite	Soil Mechanics – I [PC-CE403]		
Experiment 1	Field identification of different type of soil as per Indian standards [collection of field samples and identification without laboratory testing], determination of natural moisture content.		
Experiment 2	Determination of specific gravity of i) Cohesion less ii) cohesive soil		
Experiment 3	Determination of In-situ density by core cutter Method		
Experiment 4	Determination In-situ density by sand replacement method		
Experiment 5	Grain size distribution of cohesion less soil by sieving.		
Experiment 6	Grain size distribution of fine grained soil by hydrometer analysis		
Experiment 7	Determination of Atterberg's limit (liquid limit, plastic limit & shrinkage limit)		
Experiment 8	Determination of Atterberg's limit (liquid limit, plastic limit & shrinkage limit)		
Experiment 9	Determination of co-efficient of permeability by variable head parameter (fine grained soil).		
Reference	1. Soil Testing by T.W. Lamb (John Wiley) 2. SP-36 (Part-I & Part-II) 3. Measurement of Engineering properties of soil by E. Saibaba Reddy & K. Rama sastri.(New age International publication		

PC-CE501	DESIGN OF RCC STRUCTURES	3L + 0T	3 Credits
Course Outcome	**After going through this course, the students will be able to:** 1. Understand material properties and design methodologies for reinforced concrete structures. 2. Assess different type of loads and prepare layout for reinforced concrete structures. 3. Identify and apply the applicable industrial design codes relevant to the design of reinforcedconcrete members. 4. Analyze and design various structural elements of reinforced concrete building like beam, slab, column, footing, and staircase. 5. Assessment of serviceability criteria for reinforced concrete beam and slab. 6. Prepare structural drawings and detailing and produce design calculations and drawing in appropriate professional format.		
Prerequisite	Solid Mechanics [ES-CE401], Concrete Technology & Construction Materials [PC-CE401].		
Module 1:	**Introduction:** Principles of design of reinforced concrete members - Working stress and Limit State method of design		1L
Module 2:	**Working stress method of design:** Basic concepts and IS code provisions (IS: 456 2000)for design against bending moment and shear forces - Balanced, under reinforced and over-reinforced beam/ slab sections; design of singly and doubly reinforced sections		3L
Module 3:	**Limit state method of design**: Basic concepts and IS code provisions (IS: 456 2000) for design against bending moment and shear forces; concepts of bond stress and development length; Use of 'design aids for reinforced concrete' (SP:16).		6L
Module 4:	**Beam Design by LSM:** Analysis, design and detailing of singly reinforced rectangular, 'T', 'L' and doubly reinforced beam sections by limit state method.		4L
Module 5:	**Slab Design by LSM :** Design and detailing of one-way and two-way slab panels as per IS code provisions		2L
Module 6:	**Continuous slab and beam design by LSM:** Design and detailing of continuous beams and slabs as per IS code provisions		2L
Module 7:	**Design of Staircases by LSM**: Types; Design and detailing of reinforced concrete dog-legged staircase		3L
Module 8	**Design of Columns by LSM**: Design and detailing of reinforced concrete short columns of rectangular and circular cross-sections under axial load. Design of short columns subjected to axial load with moments (uniaxial and biaxial bending) – using SP 16.		4L
Module 9	**Design of Foundation by LSM:** Design and detailing of reinforced concrete isolated square and rectangular isolated and combined footing for columns as per IS code provisions by limit state method Design and		6L

	detailing of Pile foundation as per IS code provisions.		
IS Codes	1	IS: 456 - 2000	
	2	IS 875 – I (1987), II (1987), -III (2015), -IV(1987), V (1987)	
	3	SP: 16 Design Aid to IS 456	

CE(PC)502	STRUCTURAL ANALYSIS – I	3L + 0T	3 Credits
Course Outcome	**After going through this course, the students will be able to:** 1. Distinguish between stable and unstable and statically determinate and indeterminate structures. 2. Apply equations of equilibrium to structures and compute the reactions. 3. Calculate the internal forces in cable and arch type structures. 4. Evaluate and draw the influence lines for reactions, shears and bending moments in beams due to moving loads. 5. Use approximate methods for analysis of statically indeterminate structures. 6. Calculate the deflections of truss structures and beams.		
Prerequisite	Introduction to Solid Mechanics [ES-CE401], Engineering mechanics		
Module 1	**Basics of Structural Analysis**: Concept of static and kinematic indeterminacy, Determination of degree of indeterminacy for different types of structures. Theorem of minimum potential energy, law of conservation energy, principle of virtual work, the first and second theorems of Castigilano, Betti's law, Clark Maxwell's theorem of reciprocal deflection		4L
Module 2	**Analysis of Determinate Structures:** Portal Frames, Three hinged arches, Cables		4L
Module 3	**Deflection of Determinate Structures**: Energy methods. Unit Load method for beams, Deflection of trusses and Simple Portal Frames.		4L
Module 4	**Influence Line Diagram:** Statically determinate beams and trusses under series of concentrated and uniformly distributed rolling loads, criteria for maximum and absolute maximum moments and shear.		6L
Module 5	**Analysis of Statically Indeterminate Beams**: Theorem of three moments, Energy methods, Force method (Method of consistent deformation) [For analysis of propped cantilever, fixed beams and continuous beams (maximum two degree of indeterminacy) for simple loading case], Analysis of two hinged arch.		8L
Module 6	**Influence Line Diagram for Indeterminate Structures:** Muller – Breslauprinciple.		4L

Reference	Sl.	Book Name	Author	Publishing House
	1	Structural Analysis (Vol I & Vol II)	S S Bhavikatti	Vikas Publishing House Pvt. Ltd
	2	Structural Analysis	Ramammurtham	

	3	Strength of Materials and Theory of Structures (Vol I & Vol II)	Punmia, Jain, Jain	Laxmi Publication
	4	Structural Analysis	R.C. Hibbeler	Prentice Hall
	5	Theory of Structures	Timoshenko and Young	McGrawHill
	6	Structural Analysis	Pandit and Gupta	TMH

PC-CE503	**SOIL MECHANICS II**	**3L + 0T**	**3 credits**
Course outcome	After going through this course, the students will be able to: 1. Assess strength parameters of soils. 2. Assess the compaction and consolidation characteristics of soil for solving geotechnical problems. 3. Calculate earth pressure on rigid retaining walls on the basis of classical earth pressure theories. 4. Analyze and design rigid retaining walls (cantilever types) from geotechnical engineering consideration. 5. Evaluate the bearing capacity of shallow foundation by applying established theory. 6. Estimate settlement in soils by different methods. 7. Compute safety of dams and embankments on the basis of various methods of slope stability analysis.		
Prerequisite	Soil Mechanics- I [PC-CE403]		
Module 1	**Compaction of Soil:** Principles of Compaction, Light & Heavy Compaction Test (as per IS codes), Field Compaction, different methods, compaction machineries, Compaction Control, CBR Test (Soaked, Un-soaked &Field) as per IS recommendation.		6L
Module 2	**Compressibility & Consolidation of Soil :** Compressibility of Soils, settlement, component of settlement, elastic, primary consolidation, secondary consolidation, importance of one dimensional consolidation, consolidation test, construction of field consolidation curve for NC clay and OC clay, Compression Index, Coefficient of Compressibility, estimation of settlement, Terzaghi's Theory of One Dimensional Consolidation, Coefficient of Consolidation, Degree of consolidation, Time rate of settlement.		7L
Module 3	**Shear Strength of Soil :** Stress and strain in soils, Basic Concept of Shear Resistance & Shear Strength of Soil, Triaxial apparatus, concept of Stress Controlled & Strain Controlled Test, Behaviour of soil under initial all-round compression, drained and un-drained condition, pore water pressure, pore pressure constant, Mohr circle of stresses, concept of pole, Mohr- Coulomb failure criteria, Concept of Critical Void Ratio, Determination of Shear Parameters by Tri-axial Test, Direct Shear, Unconfined Compression Test, Vane Shear Test as per Relevant IS Codes, Determination of sensitivity of soil, concept of Stress Path- introduction, Elastic properties of soil.		8L
Module 4	**Earth Pressure Theories :** Relation between lateral pressure and strain, State of Plastic equilibrium in soils, Earth pressure at rest , Active earth pressure & passive Earth pressure, Rankin's		6L

	&Coulombs earth pressure theories, estimation of earth pressure by graphical construction.	
Module 5	**Retaining Wall:** Principal types of retaining walls, Common uses of retaining wall, Geotechnical Design of Retaining wall, stability checks, provision of drainage, pressure below retaining wall	6L
Module 6	**Stability of slopes**: finite and infinite slope, different types of slope failure, different Causes of failure, factor of safety from different criteria, Limit Equilibrium Method of Analysis, Analysis of finite and infinite slopes ,The Culmann Method, Swedish (method of slices) and friction circle method, Taglor's stability number	8L
Reference	1. Principles of Soil Mechanics & Foundation Engg. By VNS Murthy (UBS Publication) 2. Soil Mechanics and Foundation Engg. By B.C. Punnia (Luxmi Publication) 3. Introduction to Soil Mechanics By B.M. Das (Galgolia publication) 4. Soil Mechanics – by T.W. Lambe & R.V. Whitman(WEL) 5. SP-36 (Part-I & Part-II) 6. Basic & Applied Soil Mechanics by Gopal Ranjan & A.S.R. Rao (Wiley Easter Ltd.) 7. An Introduction to Geotechnical engineering – Holtz and Kovacs, Prentice Hall Principles of 8. Geotechnical Engineering – BM Das, Thomson 9. FOUNDATION ANALYSIS AND DESIGN- J. E. Bowles, The McGraw-Hill Companies, Inc 10. SOIL MECHANICS AND FOUNDATIONS – Muni Budhu; JOHN WILEY **&**SONS, INC	

PC-CE504	Environmental Engineering II	3L + 0T	3 credits
Course outcome	Af1ter going through this course, the students will be able to: 1. Define the basic concepts and terminologies of waste water engineering and solid waste management. 2. Describe different home plumbing systems for water supply and wastewater disposal 3. Apply the methods of quantifying sanitary sewage and storm sewage 4. Identify and explain the main physical, chemical and biological characteristics of wastewater and compare between different wastewater samples. 5. Understand and develop treatment plant layouts. Explain and use the main design criteria for wastewater treatment processes and the disposal methods. 6. Ability to perform basic design of the different unit operations and processes that are involved in wastewater treatment. 7. Acquire the knowledge of characteristics and various treatment technologies of solid waste and its management systems.		
Prerequisite	XII level knowledge of Physics, Chemistry, Mathematics, Biology and Environmental Science; Undergraduate level knowledge of Engineering Mechanics, Fluid Mechanics and Hydraulics; Environmental Engineering – I		
Module 1	**Sewage and Drainage** Definition of Common Terms: Sewage or Sanitary Sewage, Drainage or Storm Sewage, Sullage, Black Water, Grey Water Sewerage Systems: Separate system, Combined System, Partially Separate System; applicability, advantages and disadvantages		2L
Module 2	**Sewage and Drainage Quantity** Quantity estimation for sanitary sewage; Quantity estimation for storm sewage		4L
Module 3	**Conveyance of Sewage Sewers** Shapes; Design parameters; Operation and maintenance of sewers; Sewer appurtenances Hydraulic Design of Sewers: Partial flow diagrams and Nomograms		4L
Module 4	**Wastewater Characteristics** Physical, chemical and biological characteristics of municipal and domestic sewage; Effluent discharge standards		6L
Module 5	**Wastewater Treatment** Primary, secondary and tertiary treatment of wastewater; aerobic an anaerobic treatment options Primary and Secondary Treatment of Domestic Wastewater: Typical Flow Chart ofSTP; Screen and Bar Racks; Grit Chamber; Primary and Secondary Sedimentation Tank; Activated Sludge Process; Trickling Filter		12L
Module 6	**Sludge Handling and Disposal** Sludge Thickening; Sludge Digestion; Sludge Drying Bed, Oxidation pond, oxidation ditch, aerated lagoon, septic tank, Imhoff tank, Disposal by dilution, irrigation and farming, stream sanitation.		4L

Module 7	**Building Plumbing** Introduction to various types of home plumbing systems for water supply and waste water disposal; high rise building plumbing; Pressure reducing valves; Break pressure tanks; Storage tanks; Building drainage for high rise buildings; various kinds of fixtures and fittings used			4L
Module 8	**Solid and hazardous waste** Quality and quantity of refuse, Collection and conveyance of solid wastes. Disposal of solid waste by composting, and other methods. Hazardous waste, Types and nature of hazardous waste as per the HW Schedules of regulating authorities			4L
Reference	1	Environmental Engineering. Volume-1 and Volume-2	Garg, S.K.	Khanna Publishers
	2	Environmental Engineering	Peavy, H.S, Rowe, D.R, Tchobanoglous, G	Tata McGraw Hill Indian Edition
	3	Introduction to Environmental Engineering and Science	Masters, G.M., Ela, W.P.	Prentice Hall / Pearson
	4	Manual on Sewerage and Sewage Treatment	CPHEEO	Govt. of India
	5	Manual on Municipal Solid Waste Management.	CPHEEO	Govt. of India
	6	Hazardous and other waste (Management and Trans-boundary Movement) Rules, 2016	MoEF	Govt. of India

PC-CE505	TRANSPORTATION ENGINEERING	3L+0T	3 Credits
Course Outcome	**After going through this course, the students will be able to:** 1. Understand the knowledge of planning, design and the fundamental properties of highway materials in highway engineering. 2. Apply the knowledge of geometric design and draw appropriate conclusion. 3. Interpret the concept of different methods in design, construction of the pavement. 4. Interpret traffic parameters by applying the knowledge in traffic planning and intersection design.		
Prerequisite	Class-XII level knowledge of Physics, Mathematics and Mechanics; Undergraduate level knowledge of Engineering Statistics, Engineering Physics, Soil Mechanics and Strength of Materials.		
Module 1	**Introduction to Highway Engineering and Planning of Highway:** Scope of Highway Engineering; role of transportation in society; Jayakar Committee Report: Recommendations – CRF, IRC, CRRI; Saturation system for determination of optimum road length; Recommendations of Nagpur Road conference; Road Classification as per third 20 years road development plan (1981-2001); Basic types of Road Patterns and its scope of application		**3L**
Module 2	**Highway Alignment:** Factors controlling Highway Alignment; Engineering Surveys for Highway Alignment		**2L**
Module 3	**Highway Geometric Design:** Cross-sectional elements of highway; Design Parameters (as per IRC) – Vehicle dimensions, Carriageway width, Design speed, Frictional coefficients (Lateral and Longitudinal) etc; Design Principles of Horizontal Alignment: Camber, Sight Distance (PIEV theory, SSD, OSD, ISD); Horizontal Curves – [Radius, Super elevation, Extra widening, Set back distance, Transition curve]; Design Principles ofVertical Alignment: Gradients; Grade Compensation; Vertical Curves – Summit Curve, Valley curve.		**12L**
Module 4	**Traffic Engineering and Traffic studies:** Fundamental parameters of Traffic Flow (speed, flow, density, capacity) and their basic relations; Basics of Spot Speed Studies- Speed and Delay study- O & D study; Intersections and Channelization: At Grade and Grade Separated intersections; Conflict points; Salient features of Rotary; Traffic Signs; Signal Design – Basic concepts of IRC design method, 2 phase signal design by Webster method.		**8L**
Module 5	**Pavement Design:** Pavement materials: Bitumen, Aggregate, Subgrade soil; Types of Pavement: Flexible and Rigid pavements and their typical cross-sections; Design parameters: Wheel Load, ESWL, Tyre Pressure, CBR, Resilient Modulus & Poisson's Ratio of various layers; Subgrade Modulus etc. Design of Flexible Pavement using IRC 37(Latest edition); Design of Rigid Pavement: Wheel Stresses; Frictional Stresses and Warping Stresses; Expansion; Contraction and Construction Joints; Design of Rigid Pavement thickness; Dowel Bar and Tie Bar. Distresses in		**9L**

	Pavements			
Reference	Sl.	Book Name	Author	Publishing House
	1	Highway Engineering	Khanna, Justo and Veeraghavan	Nem Chand and Bros.
	2	Transportation Engineering: an introduction	C.J Khisty& B.K Lall.	Prentice Hall India
	3	Principles of Transportation Engineering	P. Chakraborty & A. Das	Prentice Hall India
	4	I.S Specifications on Concrete Aggregate & Bitumen	Bureau of Indian Standard	
	5	Relevant latest IRC Codes (IRC-37 – 2001, IRC 58 – 2002, IRC 73 - 1980, IRC 86 - -1983, IRC 106 – 1990, IRC 64 – 1990, IRC 15-2002	Indian Roads Congress	

MC-CE501	CONSTITUTION OF INDIA	3L + 0T	0 credits
Course outcome	**Af1ter going through this course, the students will be able to:** 1. Have general knowledge and legal literacy and thereby to take up competitive examinations. 2. Understand state and central policies, fundamental duties. 3. Understand Electoral Process, special provisions. 4. Understand powers and functions of Municipalities, Panchayats and Co-operative Societies, 5. Understand Engineering ethics and responsibilities of Engineers 6. Understand Engineering Integrity & Reliability		
Module 1	Introduction to the Constitution of India, The Making of the Constitution and Salient features of the Constitution. Preamble to the Indian Constitution Fundamental Rights & its limitations.		4L
Module 2	Directive Principles of State Policy & Relevance of Directive Principles State Policy Fundamental Duties. Union Executives – President, Prime Minister Parliament Supreme Court of India.		5L
Module 3	State Executives – Governor, Chief Minister, State Legislature HighCourt of State. Electoral Process in India, Amendment Procedures, 42nd, 44th, 74th, 76th, 86th & 91st Amendments.		5L
Module 4	Special Provision for SC & ST Special Provision for Women, Children & Backward Classes EmergencyProvisions. Human Rights –Meaning and Definitions, Legislation Specific Themes in Human Rights- Working of National Human Rights Commission in India Powers and functions of Municipalities, Panchayats and Co - Operative Societies.		5L
Reference	1. D.D. Basu, Introduction to the Constitution on India, 19th/ 20th Students Edition, PrenticeHall EEE, 2001. 2. C.E. Haries, M.S. Pritchard and M.J. Robins, Engineering Ethics, Thompson Asia, 2003. 3. M.V. Pylee, An Introduction to Constitution of India, Vikas Publishing, 2002. 4. M. Govindarajan, S. Natarajan and V.S. Senthil kumar, Engineering Ethics, Prentice Hall ofIndia Pvt. Ltd., New Delhi, 2004. 5. B.K. Sharma, Introduction to the Constitution of India, PHI Learning, New Delhi, 2011. 6. Latest Publications, Indian Institute of Human Rights, New Delhi.		

PC-CE591	RCC STRUCTURES DESIGN LAB	2P	1 credits
Course outcome	**After going through this course, the students will be able to:** 1. Understand material properties and design methodologies for reinforced concrete structures. 2. Assess different type of loads and prepare layout for reinforced concrete structures. 3. Identify and apply the applicable industrial design codes relevant to the design of reinforcedconcrete members. 4. Analyze and design various structural elements of reinforced concrete building like slab, beam, column, footing, and staircase. 5. Assessment of serviceability criteria for reinforced concrete beam and slab. 6. Prepare structural and detailing drawings and produce design calculations and drawing in appropriate professional format.		
Prerequisite	Design of RC Structures [PC-CE501]		
	Design of a small RCC framed building using Limit State method of design including preparation of necessary working drawing and report in accordance with PC-CE501		

PC-CE592	SOIL MECHANICS- II LAB	2P	1 credits
Course outcome	On completion of the course the students will be able to: 1. Perform laboratory tests to determine compaction characteristics of soil. 2. Determine shear strength parameters of soil by unconfined compression test and vane shear test. 3. Determine shear strength parameters of soil by direct shear test. 4. Perform triaxial test to determine shear strength parameters of soil. 5. Determine California Bearing Ratio (CBR) of soil. 6. Determine SPT and Field Vane Shear test 7. Prepare technical laboratory report		
Prerequisite	Soil Mechanics- I [PC-CE403] & Soil Mechanics- II [PC-CE503]		
Experiment 1	Determination of compaction characteristics of soil by is light compaction.		
Experiment 2	Determination of compressibility characteristics of soil by consolidation test		
Experiment 3	Determination of unconfined compressive strength of soil		
Experiment 4	Determination of Shear parameter of soil by Direct shear test		
Experiment 5	Determination of un-drained shear strength of soil by venue shear test.		
Experiment 6	Determination of shear parameter of soil by Tri-axial test		
Experiment 7	Determination of CBR of a soil specimen (un-soaked) as per IS code recommendation.		
Experiment 8	Determination of CBR of Soil specimen (Soaked) as per IS code recommendation.		
Experiment 9	Standard Penetration Test.		
Experiment 10	Field vane shear test.		
Reference	1. Soil testing by T.W. Lamb (Joh willey) 2. SP-36 (Part-I & Part –II) 3. Measurement of engineering properties of soil by E. Jaibaba Reddy & K. Ramasastri.		

PC-CE593	ENVIRONMENTAL ENGINEERING LAB	2P	1 credits
Course outcome	On completion of the course the students will be able to: 1. Experiment various physical characteristics for a given sample of water and wastewater 2. Determine various chemical characteristics for a given sample of water and wastewater 3. Examine the bacteriological characteristics for a given sample of water and wastewater 4. Examine the suitability of a few treatment options for a given sample of water and wastewater 5. Compare the determined quality parameters with standards to decide on the suitability of use for the tested water and disposal of tested wastewater		
Prerequisite	Class-XII level knowledge of Physics, Chemistry, Mathematics, Biology and Environmental Science; Undergraduate level knowledge of Environmental Engineering, Biology for Engineers, Chemistry Laboratory, Physics Laboratory		
Experiment 1	Determination of turbidity for a given sample of water		
Experiment 2	Determination of electrical conductivity for a given sample of water		
Experiment 3	Determination of Total Solids, Suspended Solids, Dissolved Solids and Volatile Solids in a given sample of water		
Experiment 4	Determination of pH for a given sample of water		
Experiment 5	Determination of carbonate, bi-carbonate and hydroxide alkalinity for a given sample of water		
Experiment 6	Determination of acidity for a given sample of water		
Experiment 7	Determination of hardness for a given sample of water		
Experiment 8	Determination of concentration of Iron in a given sample of water		
Experiment 9	Determination of concentration of Chlorides in a given sample of water		
Experiment 10	Determination of the Optimum Alum Dose for a given sample of water through Jar Test		
Experiment 11	Determination of the Chlorine Demand and Break-Point Chlorination for a given sample of water		
Experiment 12	Determination of amount of Dissolved Oxygen (DO) in a given sample of water		
Experiment 13	Determination of the Biochemical Oxygen Demand (BOD) for a given sample of wastewater		
Experiment 14	Determination of the Chemical Oxygen Demand (COD) for a given sample of wastewater		
Experiment 15	Determination of Coliform Bacteria: presumptive test, Confirmative test and Determination of MPN		
Reference	1. Garg, S.K. Environmental Engineering. Volume-1 and Volume-2. Khanna Publishers 2. Peavy, H.S, Rowe, D.R, Tchobanoglous, G. Environmental Engineering. McGraw Hill International Edition / Tata McGraw Hill Indian Edition 3. Sawyer, C.N., McCarty, P.L., Parkin, G.F. Chemistry for Environmental Engineering and Science. McGraw Hill International Edition / Tata		

	McGraw Hill Indian Edition 4. IS: 3025 (Different Parts), “METIHODS OF SAMPLING AND TEST (PIIYSICAL AND CHEMICAL) FOR WATER AND WASTE WATER”. 5. APHA Standard Methods for the Examination of Water and Wastewater. 6. IS: 10500 – 2012, “DRINKING WATER SPECIFICATION (SECOND REVISION)”.

PC-CE594	TRANSPORTATION ENGINEERING LAB	2P	1 credits
Course outcome	On completion of the course the students will be able to: 1. Understand the properties of materials used for construction of highways and perform the relative tests. 2. Design BC and SDBC Mix by Marshal Method of mix design. 3. Acquire knowledge about Benkelman beam Test. 4. Prepare formal reports.		
Prerequisite	Knowledge of Transportation Engineering		
Experiment 1	Shape test of aggregate		
Experiment 2	Crushing Strength Test of aggregate		
Experiment 3	Impact test of aggregate		
Experiment 4	Los Angeles Abrasion test of aggregate		
Experiment 5	Specific Gravity and Water Absorption test of aggregate		
Experiment 6	Specific Gravity test of bitumen		
Experiment 7	Penetration test		
Experiment 8	Static or Kinematic viscosity		
Experiment 9	Softening point test		
Experiment 10	Flash and Fire Point test		
Experiment 11	Ductility test		
Experiment 12	CBR value of sub-grade (Soaked and un-soaked)		
Experiment 13	Marshall Stability test		
Demonstration	Demonstration on Stripping value and Loss on heating tests of bitumen, Benkelman Beam and Bump Integrator test.		

PC-CE601	CONSTRUCTION ENGINEERING & MANAGEMENT	3L + 0T	3 Credits
Course Outcome	**On completion of the course, the students will have:** 1. An idea of how structures are built and projects are developed on the field 2. An understanding of modern construction practices 3. A good idea of basic construction dynamics- various stakeholders, project objectives, processes, resources required and project economics 4. A basic ability to plan, control and monitor construction projects with respect to time and cost 5. An idea of how to optimize construction projects based on costs 6. An idea how construction projects are administered with respect to contract structures andissues. 7. An ability to put forward ideas and understandings to others with effective communication processes		
Module 1	**Basic concepts of management:** Definition – Essence, Functions, Roles, Level. Functions of Management: Planning – Concept, Nature, Types, Analysis, Management by objectives; Organization Structure – Concept, Structure, Principles, Centralization, Decentralization, Span of Management; Organizational Effectiveness.		**2L**
Module 2	**Planning:** General consideration, Definition of aspect, prospect, roominess, grouping, circulation, Privacy. **Regulation and Bye laws** Bye Laws in respect of side space, Back and front space, Covered areas, height of building etc., Lavatory blocks , ventilation, Requirements for stairs, lifts in public assembly building, offices		**6L**
Module 3:	**Fire Protection** Firefighting arrangements in public assembly buildings, planning , offices, auditorium		**2L**
Module 4:	**Planning &Scheduling of constructions Projects** **Planning by CPM** Preparation of network, Determination of slacks or floats. Critical activities. Criticalpath. Project duration. **Planning by PERT** Expected mean time, probability of completion of project, Estimation of critical path, problems		**6L**

Module 5:	**Construction Methods basics** Types of foundations and construction methods; Basics of Formwork and Staging; Common building construction methods (conventional walls and slabs; conventional framed structure with block work walls; Modular construction methods for repetitive works; Precast concrete construction methods; Basics of Slip forming for tall structures; Basic construction methods for steel structures; Basics of construction methods for Bridges.	**4L**
Module 6	**Construction plants & Equipment** Plants & equipment for earth moving, road constructions, excavators, dozers, scrapers, spreaders, rollers, their uses. **Plants &Equipment for concrete construction** Batching plants, Ready Mix Concrete, concrete mixers, Vibrators etc., quality control.	**3L**
Module 7	**Contracts Management basics:** Importance of contracts; Types of Contracts, parties to a contract; Common contract clauses (Notice to proceed, rights and duties of various parties, notices to be given, Contract Duration and Price. Performance parameters; Delays, penalties and liquidated damages; Force Majeure, Suspension and Termination. Changes & variations, Dispute Resolution methods.	**4L**
Module 8	**Management:** Professional practice, Definition, Rights and responsibilities of owner, engineer, Contractors, types of contract	**3L**
Module 9	**Departmental Procedures** Administration, Technical and financial sanction, operation of PWD, Tenders and its notification, EMD and SD, Acceptance of tenders, Arbitration.	**2L**
References	1. Building Construction, Varghese, P.C., Prentice Hall India, 2. National Building Code, Bureau Standards of Indian 3. Construction Technology, Chudley, R., ELBS Publishers 4. Construction Planning, Methods and Equipment, Peurifoy, R.L., McGraw Hill 5. Construction Management Methods, Nunnally, S.W., Prentice Hall 6. Project Planning with PERT and CPM, Punmia, B.C., Khandelwal, K.K., Laxmi Publications	

PC-CE602	**ENGINEERING ECONOMICS, ESTIMATION & COSTING**	**2L + 0T**	**2 credits**
Course outcome	On completion of the course, the students will: 1. Have an idea of Economics in general, Economics of India particularly for public sector agencies and private sector businesses 2. Be able to perform and evaluate present worth, future worth and annual worth analyses on one of more economic alternatives. 3. Be able to carry out and evaluate benefit/cost, life cycle and breakeven analyses on one or more economic alternatives. 4. Be able to understand the technical specifications for various works to be performed for a project and how they impact the cost of a structure. 5. Be able to quantify the worth of a structure by evaluating quantities of constituents, derive their cost rates and build up the overall cost of the structure. 6. Be able to understand how competitive bidding works and how to submit a competitive bid proposal.		
Module 1	**Basic Principles and Methodology of Economics:** Demand/Supply – elasticity – Government Policies and Application. Theory of the Firm and Market Structure. Basic Macroeconomic Concepts (including GDP/GNP/NI/Disposable Income) and Identities for both closed and open economics. Aggregate demand and Supply (IS/LM). Price Indices (WPI/CPI), Interest rates, Direct and Indirect Taxes		**3L**
Module 2	**Elements of Business/Managerial Economics and forms of organizations.** Cost & Cost Control –Techniques, Types of Costs, Lifecycle costs, Budgets, Break even Analysis, Capital Budgeting, Application of Linear Programming. Investment Analysis – NPV, ROI, IRR, Payback Period, Depreciation, Time value of money (present and future worth of cash flows). Business Forecasting – Elementary techniques. Statements – Cash flow, Financial. Case Study Method.		**3L**
Module 3	**Estimation / Measurements for various items** Introduction to the process of Estimation; Use of relevant Indian Standard Specifications for the same, taking out quantities from the given requirements of the work, comparison of different alternatives, Bar bending schedules, Mass haul Diagrams, Estimating Earthwork and Foundations, Estimating Concrete and Masonry, Finishes, Interiors, MEP works; BIM and quantity take-offs; adding equipment costs; labour costs; rate analysis; Material survey-Thumb rules for computation of materials requirement for different materials for buildings, percentage breakup of the cost, cost sensitive index, market survey of basic materials. Use of Computers in quantity surveying		**9L**
Module 4	**Specifications** Types, requirements and importance, detailed specifications for buildings, roads, minor bridges and industrial structures.		**3L**

Module 5	**Rate analysis** Purpose, importance and necessity of the same, factors affecting, task work, daily output from different equipment/ productivity.			**3L**
Module 6	**Tender** Preparation of tender documents, importance of inviting tenders, contract types, relative merits, prequalification. general and special conditions, termination of contracts, extra work and Changes, penalty and liquidated charges, Settlement of disputes, R.A. Bill & Final Bill, Payment of advance, insurance, claims, price variation, etc. Preparing Bids- Bid Price build up: Material, Labour, Equipment costs, Risks, Direct & Indirect Overheads, Profits; Bid conditions, alternative specifications; Alternative Bids. Bid process management			**3L**
Module 7	**Valuation** Values and cost, gross income, outgoing, net income, scrap value, salvage value, market value, Book Value, sinking fund, capitalised value, Y. P., depreciation, obsolescence, deferred income, freehold and leasehold property, mortgage, rent fixation, valuation table			**3L**
Module 8	Introduction to Acts pertaining to-Minimum wages, Workman's compensation, Contracts, Arbitration, Easement rights.			**2L**
Reference	1	Estimating, Costing Specifications & Valuation	M Chakravarty	
	2	Typical PWD Rate Analysis documents.		
	3	Estimating and Costing in Civil Engineering (Theory & Practice)	Dutta, B.N.	UBS Publishers
	4	Distributors, Estimating and Costing in Civil Engineering: Theory and Practice including Specification and Valuations		UBS Publishers

PC-CE603	**WATER RESOURCE ENGINEERING**	**2L + 0T**	**2 Credits**
Course Outcome	**On completion of the course, the students will have:** 1. Understand the fundamentals of flow in open channels. 2. Understand the concepts of irrigation. 3. Estimate the quantity of water required by different crops in different seasons, and accordingly the irrigation water requirement. 4. Design channels and other irrigation structures required for irrigation, drainage, soil conservation, flood control and other water-management projects. 5. Learn about groundwater resources, aquifers and wells.		
Prerequisite	Fluid Mechanics & Hydraulic Machines [ES-CE301]		
Module 1	**Open Channel Flow:** Channel Characteristics and parameters, Energy-depth relationships, Specific Energy concept, Critical Flow, Hydraulic Jump, Uniform flow, Efficient sections, Slope profiles, Gradually Varied Flow, Water surface profiles, Rapidly Varied Flow, Hydraulic Jump.		**8L**
Module 2	**Irrigation:** Definition, Necessity, Scope, Benefits of Irrigation; Types, techniques and sources of irrigation; Development of irrigation in India, Quality of Irrigation Water.		**2L**
Module 3:	**Soil-water-plant Relationship:** Types of crops, cropping seasons, water requirement of crops, base period, kor period, Duty, Delta, Commanded area, Net Irrigation Requirement, Field Irrigation Requirement, Gross Irrigation Requirement, Intensity of irrigation, Consumptive use of water, estimation of evapotranspiration, Blaney-Criddle method, Modified Penman's method, Irrigation efficiencies, Frequency of irrigation.		**4L**
Module 4:	**Canal irrigation:** Classification of irrigation canals, canals in alluvium; Design of unlined canals: Kennedy's method, Lacey's method; Lined canals: advantages, materials used, typical sections, design of lined canals, economics of canal lining; Canal sections – filling, cutting, partial cutting and partial filling.		**5L**
Module 5:	**Land drainage:** Water logging issues in irrigation, provision of drains, design and maintenance of open drains, closed drains, discharge and spacing of closed drains.		**2L**
Module 6	**Groundwater Hydraulics:** Occurrence of groundwater– Aquifers, Various Types of Aquifers, Aquifer Parameters:-		**7L**

	Specific Yield, Specific Retention, Storage Coefficient, Transmissivity; Compressibility of aquifers; Equation of motion:- confined and unconfined flow; Steady radial flow towards wells- Dupuit- Thiem' theory of well hydraulics- for both unconfined and confined aquifers, Well losses, Specific capacity of well and efficiency; Unsteady radial flow in confined aquifer:- Theis method, Cooper-Jacob method, Chow method; Unsteady radial flow in unconfined aquifer, delayed yield; Aquifer Recharge; Concept of Sea water intrusion.	
Module 7	**Wells:** Definition, types- Open well or Dug well, Tube well. Open well- Shallow open well, Deep open well, Cavity formationin open wells, construction of open wells, yield of an open well equilibrium pumping test, Recuperating test. Tube wells – Strainer type, Cavity type & Slotted type, Construction & Boring of tube wells. Radial collector wells and infiltration galleries.	**3L**
References	1. Flow in open channels, K. Subramanya, Tata McGraw-Hill. 2. Engineering Hydrology, K. Subramanya, Tata McGraw-Hill. 3. Irrigation Engineering and Hydraulic Structures, Santosh Kumar Garg, Khanna Publishers 4. Groundwater Hydrology, David K. Todd and Larry W. Mays, Wiley India Pvt Ltd. 5. Irrigation Engineering and Water Resources, G. L. Asawa, New Age Publishers, New Delhi, 2005.	

PC-CE604	DESIGN OF STEEL STRUCTURE	2L + 1T	3 Credits
Course Outcome	**On completion of the course, the students will have:** 1. Identify the material properties of structural steel. Moreover, the students will identify different bolted and welded connections, analyze and design them for axial and eccentric loads. 2. Design different steel sections subjected to axial compression and tension following Indian codes of practices. 3. Comprehend the differences between laterally supported and unsupported flexure members. Designing of the flexure members using Indian codes of practice. 4. Analyze and design rolled and built up compression members along with base connection subjected to axial compression, bending and tension. 5. Calculate shear force and bending moment on rolled and built up girders, dimension the section and finally design it following Indian standard design guidelines. 6. Identify different components of gantry system, calculate lateral and vertical loads acting on the system, dimension the components and design them. 7. Design different components of an industrial building.		
Prerequisite	Solid Mechanics [ES-CE401]		
Module 1	**Materials and Specification:** Rolled steel sections, mechanical properties of steel and their specifications for structural use. Codes of practices. Design of Steel structures using tubular, rectangular and square section		1L
Module 2	**Structural connections:** Riveted, welded and bolted including High strength friction grip bolted joints. – types of riveted & bolted joints, assumptions, failure of joints ,efficiency of joints, design of bolted ,riveted & welded joints for axial load. Eccentric connection:- Riveted & bolted joints subjected to torsion & shear, tension & shear, design of riveted, bolted & welded connection.		6L+2T
Module 3:	**Design of Tension members:** Design of tension members, I.S code provisions. Permissible stresses, Design rules, Examples.		3L+1T
Module 4:	**Design of Compression members:** Effective lengths about major & minor principal axes, I.S code provisions. Permissible stresses, Design rules, Design of one component, two components and built up compression members under axial load. Examples. Built up columns under eccentric loading: Design of lacing and batten plates, Different types of		6L+2T

	Column Bases- Slab Base , Gusseted Base, Connection details	
Module 5:	**Design of Beams:** Permissible stresses in bending, compression and tension. Design of rolled steel sections, plated beams. Simple Beam end connections, beam -Column connections. I.S code provisions	**4L+1T**
Module 6	**Design of Plate girders:** Design of webs & flanges, Concepts of curtailment of flanges – Riveted & welded web stiffeners, web flange splices - Riveted, welded& bolted.	**4L+1T**
Module 7	**Design of Gantry Girder:** Design gantry girder considering lateral buckling – I.S code provisions.	**4L+1T**
References	1. IS 800 – 2007(Latest Revised code) 2. IS 875 – I (1987), II (1987), -III (2015), -IV(1987), V (1987) 3. S.P.: 6(1) – 1964 Structural Steel Sections 4. IS 1161 : 2014 5. Steel structures, N. Subramanian, OXFORD University Press 6. Design of Steel Structures, S.K. Duggal, TMH 7. Design of Steel Structures, Bhavikatti I.K., Publishing House	

PC-CE605	FOUNDATION ENGINEERING	2L+0T	2Credits
Course Outcome	**On completion of the course, the students will have:** 1. Determine bearing carrying capacity of shallow foundation 2. Determine the capacity of pile foundation. 3. Compute the efficiency and settlement of pile group. 4. Understand different subsoil exploration methods and interpret field and laboratory test data to obtain design parameters for geotechnical analysis. 5. Correlate bearing capacity of shallow foundation from field test data. 6. Understand and apply various types of ground improvement methods for solving complex geotechnical problems.		
Prerequisite	Soil Mechanics – I (PC-CE403), Soil Mechanics – II (PC-CE503).		
Module1	**Soil Exploration**: Purpose, Reconnaissance, Planning of sub-surface explanation, depth and number of exploration, different methods of exploration, Trial pits, Hand auger borings, Mechanical Auger borings, Wash borings, Percussion drillings, Rotary drillings sampling, collection of soil samples (un-disturbed and disturbed), collection of rock core, determination of RQD In-situ tests: SPT, SCPT, DCPT, field vane shear , Plate load test, Bore log, preparation of sub-soil Investigation report.		**10L**
Module2	**Foundations**: load on foundation, depth of foundation, shallow and deep foundations, selection criteria,		**1L**
Module3:	**Shallow foundations**: different types of footings, depth of building and bridge foundation, Bearing capacity, gross and net capacity, different types of failure, Terzaghi's bearing capacity theory, other methods, effect of depth of embedment, effect of water table, inclined load, effect of foundation shape, eccentricity of load,choice of c-ϕ for determination of bearing capacity, Bearing capacity on layered media, Bearing capacity as per 1S 6403.		**10L**
Module4:	**Settlement:** Immediate and consolidation settlement, correction for rigidity and dimensional effects, settlement in various types of soil, IS-1904 recommendations.		**6L**

	Determination of allowable bearing capacity from in-situ test- SPT, SCPT and Plate load test.	
Module5:	**Deep foundations:** Pile: Types, load transfer mechanism, classification based on material, method of installation of piles and use, construction of pile, Determination of load carrying capacities of piles by static, Dynamic formulae, and pile load test,capacity of Pile group, Group efficiency, Negative skin friction **Caissons:** types, construction, construction problems & remedies, load carrying capacity	**9L**
Module6	**Ground Improvement:** purpose, different Techniques – flooding, vibration, vibro-flotation, dynamic compaction, blasting, compaction grouting, reinforcement technique: stone column, compaction piles, improvement by preloading, sand drain.	**6L**
References	1. Foundation Analysis & Design By J.E. Bowels (McGraw Hill) 2. Principles of Foundation Engg. By B.M. Das (PWS Publishing) 3. Soil Mechanics & foundation Engg. By VNS Murthy. 4. SP- 36 (Part I & Part II) 5. Foundation Engineering By S.P Brahma 6. Relevant IS Codes. Etc. 7. SOIL MECHANICS AND FOUNDATIONS – Muni Budhu; JOHN WILEY **&**SONS, INC 8. Theory and Practice of Foundation design –Som and Das, PHI 9. Relevant IS Codes. Etc.	

PC-CE606	STRUCTURAL ANALYSIS – II	2L + 0T	2 Credits
Course Outcome	**After going through this course, the students will be able to:** 1. Apply the Slope Deflection and Moment Distribution Method to analyze indeterminate structures. 2. Develop and analyze the concept of suspension bridge and stiffness girders. 3. Apply and analyze the concepts of curved beam analysis in hooks, rings and Bow girders. 4. Develop the concept bending in unsymmetrical beams. 5. Develop the fundamental concepts of plastic analysis using kinematic method and apply them in frames and continuous beam analysis. 6. Develop and analyze the portal frames using Portal and Cantilever method. 7. Develop and analyze the indeterminate structures (continuous beams and frames) using flexibility and stiffness matrix method.		
Prerequisite	Solid Mechanics [ES-CE401], Structural Analysis – I [PC-CE502]		
Module 1	**Analysis of statically Indeterminate Structures:** Moment distribution method-solution of continuous beam, effect of settlement and rotation of support, frames with or without side sway. Slope deflection method: method and application in continuous beams and frames. Suspension Bridge and stiffening girders.		8L
Module 2	**Curved Beam analysis:** Hooks, rings and Bow girders. Unsymmetricalbending.		8L
Module 3	**Plastic analysis of structures:** Beams and portal frames.		5L
Module 4	**Approximate method of analysis of structures:** Portal and Cantilever methods.		4L
Module 5	**Matrix methods of structural analysis:** Stiffness and flexibility approachesfor analysis of beam.		5L
References	1. Structural Analysis (Vol I & Vol II), S S Bhavikatti, Vikas Publishing House Pvt. Ltd 2. Structural Analysis, Ramammurtham 3. Strength of Materials and Theoryof Structures (Vol I & Vol II), Punmia, Jain, Jain, Laxmi Publication 4. Structural Analysis, R.C. Hibbeler, Prentice Hall 5. Theory of Structures, Timoshenko Young 6. Structural Analysis, Pandit and Gupta, TMH 7. Theory Analysis of Matrix		

<table>
<tr><td>OE-CE601A</td><td colspan="2">Soft Skills and Interpersonal Communication</td><td>2L + 0T</td><td>2 Credits</td></tr>
<tr><td>Course Outcome</td><td colspan="4">1. Analyse the dynamics of business communication and communicate accordingly.
2. Write business letters and reports
3. Learn to articulate opinions and views with clarity
4. Appreciate the use of language to create beautiful expressions
5. Analyse and appreciate literature.
6. Communicate in an official and formal environment.</td></tr>
<tr><td>Module 1</td><td colspan="3">Communication Skill Definition, nature & attributes of Communication Process of Communication Models or Theories of Communication Types of Communication Levels or Channels of Communication Barriers to Communication</td><td>3L</td></tr>
<tr><td>Module 2</td><td colspan="3">Business Communication- Scope & Importance Writing Formal Business Letters Writing Reports Organizational Communication: Agenda & minutes of a meeting, notice, memo, circular Project Proposal Technical Report Writing Organizing e-mail messages E-mail etiquette Tips for e-mail effectiveness</td><td>8L</td></tr>
<tr><td>Module 3</td><td colspan="3">Language through Literature Modes of literary &non-literary expression Introduction to Fiction, (An Astrologer's Day by R.K. Narayan and Monkey's Paw by W.W. Jacobs), Drama (The Two Executioners by Fernando Arrabal) or (Lithuania by Rupert Brooke) & Poetry (Night of the Scorpion by Nissim Ezekiel and Palanquin Bearers by Sarojini Naidu)</td><td>8L</td></tr>
<tr><td>Module 4</td><td colspan="3">Grammar in usage (nouns, verbs, adjectives, adverbs, tense, prepositions, voice change) - to be dealt with the help of the given texts.</td><td>10L</td></tr>
<tr><td rowspan="3">Reference</td><td>Sl.</td><td>Book Name</td><td>Author</td><td colspan="2">Publishing House</td></tr>
<tr><td>1</td><td>Theories of Communication: A Short Introduction</td><td>Armand Matterlart and Michele Matterlart</td><td colspan="2">Sage Publications Ltd</td></tr>
<tr><td>2</td><td>Professional Writing Skills</td><td>Chan, Janis Fisher, and Diane Lutovich</td><td colspan="2">San Anselmo, CA: Advanced Communication Designs, 1997.</td></tr>
</table>

	3	Writing and Speaking at Work: APractical Guide for Business Communication	Edward P.Bailey	Prentice-Hall
	4	Intercultural Business Communication	Lillian Chaney and Jeanette Martin	Prentice Hall

OE-CE601B	**Introduction to Philosophical Thoughts**	**2L + 0T**	**2 Credits**
Module 1	Introduction to Indian Philosophy: Brief discussion on Veda and Upanishads; Origin of Indian Philosophy		**1L**
Module 2	Charvaka Philosophy: Epistemology; Metaphysics		**2L**
Module 3	Samkhya Philosophy: Metaphysics; Theory of Causation. --Prakṛti, Purusa, Evolution; Epistemology		**3L**
Module 4	Yoga Philosophy: Organization of the Yoga Sutras; Psychology of Yoga - Stages of Citta, Forms of Citta, Modifications of Citta, Kinds of Klesas; The Eight-Fold Yoga; God and Liberation		**3L**
Module 5	Nyaya Philosophy : Epistemology - Perception (Pratyaksa), Inference (Anumāna), Comparison (Upamāna), Testimony (Sabda); Theory of Causation (Asatkāryavāda); Self and Liberation; The Concept of God		**5L**
Module 6	Mimansa Philosophy: Epistemology -- Validity of Knowledge; Sources of Valid Knowledge (Pramāna) – Perception, Inference, Comparison, Verbal Testimony, Postulation (Arthapati), Non Apprehension (Anupalabdhi); Theories of Error (Khyativāda) – Akhyativāda, AnirvacaniyaKhytivāda, Viparitakhyativāda; Metaphysics -- Theory of Causation; Nature of Self; God and Liberation		**4L**
Module 7	Vaisesika Philosophy: Metaphysics and the Categories -- Substance (Dravya), Quality (Guṇa), Action (Karma), Generality (Sāmānya), Particularity (Vaiśeṣa), Inherence (Samavāya), Nonexistence (Abhāva); Epistemology; The Concept of God; Bondage and Liberation		**3L**
Module 8	Buddhist Philosophy: Epistemology - Dependent Origination; Four Noble Truths; Eight Fold Paths; Ethics; Karma and Rebirth; Liberation		**4L**
Module 9	Jaina Philosophy: Syādavāda; Anekāntavāda; Ethics; Karma and Liberation		**3L**

OE-CE601C	ECONOMIC POLICIES IN INDIA	2L + 0T	2 Credits
Module 1	**Economic Development and Growth Policies:** Economic Development & Social Opportunity - Development, Freedom and Opportunity on education & health, the government, the state & the market; Human Development - Essential Components of Human development; Indexing Human Development in India - indicators, scaling and composition; Recasting Planning in terms of Human Development; Indian Political Economy (1980-2010) and Inclusive Growth, Poverty in India - estimates and methodological controversies; Human Poverty, entitlement, capability approach; Public Action and Social Inequality - public, its role, reach of inequalities, Social inequalities and economic reforms, basic equalityand social security and Health care, local goverance & social reforms.		8L
Module 2	**Agriculture and Industrial Sectors of the Indian economy**: Agriculture Growth and Industrial Performance in Indian - salient features of industrial and agriculture growth, links between agriculture and industry - production linkages, demand linkages, savings & investment linkages; Planning for Agriculture - 21st Century perspective, Indian agriculture - emerging perspectives and policy issues; Land System and its reforms in India - land reforms progress in postindependent India. Impact of Structural Reorganization, emerging perspectives & Policy Issues; Critical appraisal of Food Security Policy; Water Resource Development Strategy for Accelerating Agriculture Production in India; Terms of Trade Between Agriculture and Industry : Industrial growth in 80's - some issues; Government Policy Towards Public Sector Since 1991; Paradigm shift in Industrial Policy; Jobless Growth in Indian manufacturing in 2000s		8L
Module 3	**Indian Planning:** Objectives & strategy of Planning in India; RegionalPlanning Policy in India - regional imbalances in India and policy measures to remove regional imbalances, critical review of Regional Planning in India; Economic Growth and Social Attainment - the role of Development Strategy; Gender Responsive Budgeting and Gender Equity; Federal Finances - responsibilities and resources, division of functions, resource raising powers, transfer of resources through Twelfth and Thirteen finance Commission; Parallel		6L

	Economy - causes and remedies, current status of the Black Money - Graying of India's Political economy.	
Module 4	**Economic Reforms & External Sector:** Growth & Macro Economic Imbalances in India-linkages between growth & fiscal & external balances, trends in fiscal & external deficits; Critical Appraisal of Economic Reforms; WTO - Uruguay Round of Final Act & its Implication for India, Impact of WTO on various aspects of IndianEconomy, India's Role at Doha Ministerial Conference, Geneva Frame Work and update on Trade Negotiations; Foreign Trade Policy - Import - Export Policy in pre-reform period, New Trade Policy - The Reform Period, ForeignTrade Policy 2009-14; FDI in Multi-brand Trade & Safe Guards.	6L
References	1. Bardhan, Pranab (1994): The Political Economy of Development in India; Oxford University Press, New Delhi 2. C.T. Kurian (1978) : Poverty Planning and Social Transformation - An Alternative in Development Planning Allied Publishers, New Delhi 3. V. M. Dandekar: The Indian Economy 1947-97; transforming traditional Agriculture Vol. I' 4. Bimal Jalan : Indian Economic Crisis : The Way Ahead; Oxford University Press, New Delhi 1992 5. India's Economic Policy Preparing for the 21st Century: Penguin. New Delhi, 1996. 6. A. P. 'Thirwall' Growth and Development, 6th Edition Macmillan Press Ltd., 1999. 7. Vijay Joshi: IMD Little; India's Economy Reforms; Oxford University Press. New Delhi, 1991-2001. 8. Usha Kapila Indian Economy since Independence; Vol. I, II & III, Academic Foundation. New Delhi.	

PC-CE691	**STEEL STRUCTURE DESIGN SESSIONAL**	**3P**	**1.5 Credits**
Course Outcome	**After going through this course, the students will be able to:** 1. Identify the material properties of structural steel. Moreover, the students will identify different bolted and welded connections, analyze and design them for axial and eccentric loads. 2. Design different steel sections subjected to axial compression and tension following Indian codes of practices. 3. Comprehend the differences between laterally supported and unsupported flexure members. Designing of the flexure members using Indian codes of practice. 4. Analyze and design rolled and built up compression members along with base connection subjected to axial compression, bending and tension. 5. Calculate shear force and bending moment on rolled and built up girders, dimension the section and finally design it following Indian standard design guidelines. 6. Identify different components of gantry system, calculate lateral and vertical loads acting on the system, dimension the components and design them. 7. Design different components of an industrial building.		
Prerequisite	Design of Steel Structures (PC-CE604)		
	Design of a factory shed including preparation of necessary working drawings and report in accordance with [PC-CE604]		

PC-CE692	**WATER RESOURCE ENGINEERING LABORATORY**	**2P**	**1 Credits**
Course Outcome	**On successful completion of this course, student should be able to:** 1. Delineate the watershed of any reservoir using DEM. 2. Determine the average rainfall over a catchment. 3. Use the rain gauge properly for a specified purpose. 4. Measure the rate of infiltration of water through the soil. 5. Measure the sunshine hours in a particular day.		
Prerequisite	Engineering Hydrology [PC-CE402] & Water Resources Engineering [PC-CE603]		
Experiment 1	Catchment area delineation (Manually and using DEM)		
Experiment 2	Calculation of average rainfall over a catchment area with arithmetic mean method, Thiessen polygon method and Isohyetal Method.		
Experiment 3	Use of different type of Rain gauges.		
Experiment 4	Measurement of infiltration rate using double ring infiltrometer.		
Experiment 5	Measurement of evaporation using evaporimeter.		
Experiment 6	Measurement of bright sunshine hours using sunshine recorder.		

PC-CE693	**Quantity Survey Estimation and Valuation Sessional**	**3P**	**1.5 credits**
Course outcome	**The subject aims to provide the student with:** 1. An introduction to quantity surveying 2. The capability to know analysis and schedule of rates 3. The ability to know specification of materials 4. An understanding about specification of works 5. The introduction to valuation		
Prerequisite	Construction Engineering & Management, [PC-CE601], Engineering Economics, Estimation & Costing, [PC-CE602]		
	1. Quantity Surveying: Types of estimates, approximate estimates, items of work, unit of measurement, unit rate of payment. 2. Quantity estimate of a single storied building 3. Bar bending schedule. 4. Details of measurement and calculation of quantities with cost, bill of quantities, abstract of quantities. 5. Estimate of quantities of road, Underground reservoir, Surface drain, Septic tank. 6. Analysis and schedule of rates: Earthwork, brick flat soling, DPC, PCC and RCC, brick work, plastering, flooring and finishing, 7. Specification of materials: Brick, cement, fine and coarse aggregates 8. Specification of works: Plain cement concrete, reinforced cement concrete, first class brickwork, cement plastering, pointing, white washing, colour washing, distempering, lime punning, painting and varnishing 9. Valuation: Values and cost, gross income, outgoing, net income, scrap value, salvage value, market value, Book Value, sinking fund, capitalised value, Y. P., depreciation, obsolescence, deferred income, freehold and leasehold property, mortgage, rent fixation, valuation table		

PC-CE694	**COMPUTER APPLICATIONS IN CIVILENGINEERING**	**2P**	**1 Credits**
Course Outcome	**On successful completion of this course, student should be able to:** 1. Use the computer as a problem-solving tool. 2. Identify and formulate Civil Engineering problems solvable by computers. 3. Perform linear algebra and matrix operations and their application to solve Civil Engineering problems 4. Solve sets of linear equations and determine roots and nonlinear equations 5. Construct, interpret and solve simple optimization problems 6. Develop programs for Civil Engineering analysis and design problems. 7. Use various software used in industries for analysis and design.		
Prerequisite	Programming for Problem Solving, Computer-aided Civil Engineering Drawing.		
Module 1	**Introduction:** Concept of problem-solving using computer, use of programming language and software for problem solving; Identification of various design and analysis problems in different fields of Civil Engineering to be solved using computers; Procedure, formulae and data related to the analysis and design of such problems.		
Module 2	**Use of spreadsheets:** Learning spreadsheets like MS Excel, matrix analysis, use of Goal Seek and Solver, Optimization Tools; Plotting. Applications to problems involving tabular data, CE estimation, surveying, and design problems.		
Module 3	**Programming Languages:** Learning at least one language: Fortran 2003/2008/2018, C++11/C++14, Python 3, VBA 7.0; Computing platforms like Matlab/Scilab/MathCAD; Solving analysis and design problems in areas like surveying, hydraulics, structural analysis, RCC design, soil mechanics and foundation, transportation, water resources, etc.		
Module 4	**Use of Software:** Familiarity with widely used Civil Engineering software like STAAD Pro, HEC- RAS, HEC-HMS, SWMM, Mx Roads, etc.; Solving at least two such analysis/design problems.		

HU-CE701	FINANCIAL MANAGEMENT AND ACCOUNTS	3L	3 credits
Course outcome	**After going through this course, the students will be able to:** 1. Explain the concept of fundamental financial concepts, especially time value of money. 2. Apply capital budgeting projects using traditional methods. 3. Analyse he main ways of raising capital and their respective advantages and disadvantages in different circumstances. 4. Integrate the concept and apply the financial concepts to calculate ratios and do the capital budgeting		
Prerequisite	Knowledge of Class-X level mathematics		
Module 1	**Introduction:** Financial Management, Financial Planning and Capitalization- definitions, objectives, changing roles and functions, Financial Decision.		**4L**
Module 2	**Capital Budgeting:** Nature of Investment decision, Importance of Capital Budgeting, The Capital. Budgeting Process - Investment Criterion, Pay-back period, Accounting, ROR (Rate of Return) Method, Discounting Cash flow method, Net - present value method, IRR (Internal Rate of Return) method, The benefit-Cost Ratio method.		**8L**
Module 3	**Management of Working Capital:** Various concepts, Elements, Classification, Financing and importance of working capital, Investment analysis, Cashflow determination, cost of capital, capital budgeting methods.		**5L**
Module 4	**Budgeting Control Technique:** Concepts of Budget, budgeting and budgetary control, Objectives, Functions, Uses, Advantages, Limitations; Master Budget and Report.		**4L**
Module 5	**Cost - Volume - Profit Analysis:** Classification of costs, Allocation, apportionment and absorption, Cost centres, different costing systems, Cost analysis for managerial decisions, Meaning of Linear CVP analysis, Objectives, Assumptions, Break- Even analysis, determining the Break-Even point profit, Volume graph profit, Volume ratios margin of Safety.		**8L**

Module 6	**Introduction to Accounting:** Basic accounting concepts, important definitions, uses, limitations, advantages; types of Accounting, Financial statements, introduction to Journal Accounting; different types of Vouchers, double entry Book keeping, different types of transactions related to Financial Accounting.	**4L**
Module 7	**Financial Control:** Posting of Ledgers and preparation of Trial Balance; preparation of Balance Sheet and Profit and Loss Accounts; Controlling other departments by Financial Accounting (A practical Approach).	**6L**

Reference	1	Financial Management and Accounting - P. K. Jain, S. Chand & Co.
	2	Management & Accounting: Principles and Practice- R. K. Sharma & Shashi Kumar Gupta, Kalyani Publishers.
	3	Advanced Management Accounting - Kaplan & Atkinson, PHI.
	4	Fundamentals of Financial Management - Van Home, PE.
	5	Financial Management Accounting, Gupta, Pearson
	6	Financial Management, I.M. Pandey, Vikas
	7	Financial Management., Khan & Jain, TMH
	8	Financial Management , Mc Menamin, OUP
	9	Financial Management & Policy, Van Horne, PHI
	10	Financial Management, Kulkarni & Satyaprasad, Himalaya

OE-CE701A	METRO SYSTEM AND ENGINEERING	3L	3 credits
Course outcome	**After going through this course, the students will be able to:** 1. To acquire & understand the necessity of metro system for urban transport. 2. To acquire & understand the differences between various urban transport system. 3. To understand cost effectiveness of various urban transport systems.		
Prerequisite	Knowledge of Transportation system		
Module 1	Overview of Metro Systems; Need for Metros; Routing studies; Basic Planning and Financial		4L
Module 2	**CIVIL ENGINEERING** Overview and construction methods for: Elevated and underground Stations; Viaduct spans and bridges; Underground tunnels; Depots; Commercial and Service buildings. Initial Surveys & Investigations; Basics of Construction Planning & Management, Construction Quality & Safety Systems. Traffic integration, multimodal transfers and pedestrian facilities; Environmental and social safeguards; Track systems-permanent way. Facilities Management		12L
Module 3	**ELECTRONICS AND COMMUNICATION ENGINEERING** Signalling systems; Automatic fare collection; Operation Control Centre (OCC and BCC); SCADA and other control systems; Platform Screen Doors.		5L
Module 4	**MECHANICAL & TV + AC** Rolling stock, vehicle dynamics and structure; Tunnel Ventilation systems; Air conditioning for stations and buildings; Fire control systems; Lifts and Escalators		5L
Module 5	**ELECTRICAL:** OHE, Traction Power; Substations- TSS and ASS; Power SCADA; Standby and Back-up systems; Green buildings, Carbon credits and clear air mechanics		5L
Reference	1. Metro Act _ Government of India – 2002 2. Rolling Stock – Report of Ministry of Urban Development – GOI - 2013 3. Radio communication for Communications-Based Train Control (CBTC): A tutorial and survey – 2017 4. Technical Details of Metro Rolling Stock _ Ansaldo Manual – 2016 5. Technical Details of Metro Rolling Stock – Bombardier – 2015 6. Technical Standards of Track Structure for Metro Railways/MRTS – RDSO 7. Detailed Project Reports of Various Metro Projects in India – By Delhi Metro Rail Corporation		

OE-CE701B	ICT FOR DEVELOPMENT	3L	3 credits
Course outcome	ICT curriculum is intended for fostering the development of information and communication technologies knowledge and skills in view of achieving general digital literacy, while ensuring equal opportunities for all students. They foster in students the development of critical analysis of the function and power of information and communication technologies, while developing technology-assisted information search, processing, production and communication skills, combined with traditional search methods (books, magazines, encyclopaedia, newspapers and other information media).		
Prerequisite			
Module 1	**Introduction to ICT:** New media and ICT, Different types of ICT. Use of ICT for development; e-learning; Web commerce; Mobile telephony and Development: telecom industry in India. ICT Projects implemented in India and Northeast – Problems and Prospects		**7L**
Module 2	**Digital Revolution and Digital Communication:** Basics of New media theories – Information Society; Surveillance society; Digital Divide, Knowledge society; Network society. Works of Machlup, Bell, Negroponte and Castells		**6L**
Module 3	**Technology and Development:** ICT for Development its societal implications; Evolution of ICT in Development Endeavour; ICT and Millennium Development Goals. Democratic and decentralized processes in development. Technology and culture: community and identity; participatory culture and ICT, community informatics		**8L**
Module 4	**Computer Mediated Communication and development:** Different types of CMC; Important theoretical framework of CMC, cyber platform and communities, Social Networking Site; Convergent media, Multimedia platforms, Scope of convergent journalism for Development; Characteristics of convergent journalism; Different types of convergent journalism: precision journalism; annotative and open-source journalism; wiki journalism; open source journalism; citizen journalism; back- pack journalism, Convergent technologies and applications; Multimedia convergence and Interactivity		**10L**

PE-CE703A	CYBER LAW & ETHICS		3L	3 credits
Course outcome	**After going through this course, the students will be able to:** 1. Identify and analyse statutory, regulatory, constitutional, and organizational laws that affect the information technology professional. 2. Students locate and apply case law and common law to current legal dilemmas in the technology field. 3. Apply diverse viewpoints to ethical dilemmas in the information technology field and recommend appropriate actions. 4. Distinguish enforceable contracts from non-enforceable contracts. 5. Demonstrate leadership and teamwork.			
Prerequisite	Basic knowledge computer and internet			
Module 1	**Introduction:** Basics of Law, Understanding Cyber Space, Defining Cyber Laws, Scope and Jurisprudence, Concept of Jurisdiction, Cyber Jurisdiction, Overview of Indian Legal System, Introduction to IT Act 2000, Amendments in IT Act, Cyber Laws of EU – USA – Australia - Britain, other specific Cyber laws			**7L**
Module 2	**Computer Ethics, Privacy and Legislation:** Computer ethics, moral and legal issues, descriptive and normative claims, Professional Ethics, code of ethics and professional conduct. Privacy, Computers and privacy issue, Digital Evidence Controls, Evidence Handling Procedures, Basics of Indian Evidence ACT, Legal Policies, legislative background			**7L**
Module 3	**Intellectual Property Rights Issues:** Copyrights, Jurisdiction Issues and Copyright Infringement, Multimedia and Copyright issues, WIPO, Intellectual Property Rights, Understanding Patents, Understanding Trademarks, Trademarks in Internet, Domain name registration, Software Piracy, Legal Issues in Cyber Contracts, Authorship, Document Forgery			**7L**
Module 4	**Indian IT Act and Standards:** Indian IT ACT, Adjudication under Indian IT ACT, IT Service Management Concept, IT Audit standards, ISO/IEC 27000 Series, COBIT, HIPPA, SOX, System audit, Information security audit, ISMS, SoA (Statement of Applicability), BCP (Business Continuity Plan), DR (Disaster Recovery), RA (Risk Analysis/Assessment)			**4L**
Module 5	**International Laws governing Cyber Space:** Introduction to International Cyber Law, UNCITRAL **Cyber Laws:** Legal Issues and Challenges in India, Net neutrality, Role of INTERPOL.			**6L**
Reference	1	Computer Ethics	Deborah G. Johnson	Pearsons Education
	2	Cyber Law Simplified	Vivek Sood	McGraw Hill Education
	3	Cyber frauds, cybercrimes & law in India	Pavan Duggal	Saakshar Law Publications
	4	The Internet Law of India: Indian Law Series	Shubham Sinha	Create Space Independent Publishing Platform

PE-CE701A	GIS & REMOTE SENSING	3L	3 credits
Course outcome	**After going through this course, the students will be able to:** 1. Define and state the scope GIS & remote sensing in civil engineering 2. Understand the basic principles of remote sensing and GIS 3. Apply the various methods of remote sensing and GIS to different geospatial datasets 4. Analyze the different results obtained from different remote sensing data sources 5. Evaluate the different results in solving real world problems. 6. Design and construct optimum solutions for real world problems that can be resolved by GIS & remote sensing		
Prerequisite	Knowledge of Class-XII level physics, Surveying & Geomatics PC-CE301		
Module 1	**Fundamentals of Remote Sensing:** Energy sources and radiation principles; Electromagnetic Spectrum; Energy interactions in the atmosphere and with earth surface features; Atmospheric windows; Spectral response patterns and spectral signatures.		**4L**
Module 2	**Digital Image Processing:** Image rectification and restoration; Image enhancement; Image classification; Accuracy assessment; Digital change detection; Spatial, spectral, radiometric and temporal resolution characteristics of IRS, Landsat and Sentinel data.		**6L**
Module 3	**Advanced Remote Sensing:** Microwave remote sensing: Frequency and wavelengths, polarization, range and azimuth resolution, relief displacement, foreshortening, layover, shadows and speckles; Synthetic Aperture Radar (SAR); Indian microwave sensors; Working principles of LiDAR remote sensing.		**3L**
Module 4	**Advanced Digital Image Processing:** Principal Component Analysis (PCA); Colour Space Transformation; Fourier Transformation; Image fusion; Hybrid classification system.		**4L**
Module 5	**GIS:** Definition, components and applications of GIS; Spatial and attribute data; Raster vs. Vector GIS; Concept of topology; Non-topological data structures		**4L**
Module 6	**Database and Coordinate System:** Concepts of Relational Data Base Management System (RDBMS) and geodatabase; Spatial and attribute query; Datum and projection; Universal Transverse Mercator (UTM) grid system; On-the-fly projection		**2L**
Module 7	**Spatial Data Analysis:** Concepts of local, focal, zonal and global analysis; Proximity analysis; Distance measurement; Raster and vector overlay; Spatial interpolation; DEM and TIN, Cost surface analysis		**6L**

Module 8	**Applications of GIS & Remote Sensing:** Watershed analysis; Runoff and erosion modelling, Location and allocation analysis; Atmospheric pollution monitoring; Urban growth modelling; Carbon sequestration and climate change.			**5L**
Reference	1	Remote Sensing and Image Interpretation	Thomas M. Lillesand Ralph W. Kiefer Jonathan W. Chipman	Wiley India Edition
	2	Introduction to Geographic Information Systems	Kang-tsung Chang	Tata McGraw-Hill Publishing Company Limited
	3	Remote Sensing and GIS	Basudeb Bhatta	Oxford University Press
	4	Remote Sensing of Environment: An Earth Resource Perspective	J. R. Jensen	Pearson
	5	Applications of Geomatics in Civil Engineering	J. K. Ghosh I. de Silva (Eds.)	Springer
	6	Introductory Digital Image Processing: A Remote Sensing Perspective	J. R. Jensen	Pearson
	7	Concepts and Techniques of Geographic Information Systems	C. P. Lo A. K. W. Yeung	Pearson

PE-CE701B	PAVEMENT DESIGN AND CONSTRUCTION	3 L	3 Credits

Course Outcome	**After going through this course, the students will be able to:** 1. Differentiate between different types of pavements, both structurally and functionally. 2. Conduct Axle Load Survey and Estimate Design Traffic. 3. Analyse and design bituminous and cement concrete pavement using. 4. Understand the principles of Pavement Maintenance and identify various pavement distresses.	
Prerequisite	Transportation Engineering (PC-CE505)	
Module 1	**Pavement Design:** Flexible Pavement Design: Stresses and Deflections in homogeneous masses.; Burmister's two layer theory; Three layer and multi-layer theories; wheel load stresses, various factors in traffic wheel loads; ESWL of multiple wheels; McLeod method of design; AASTHO method of flexible pavement design. Low Volume Rigid Pavement: Criteria of Load, Scope and Specifications as per different Government policies in India, Design Criteria	**13 L**
Module 2	**Pavement Construction and Management:** Flexible Pavement Construction: Earthwork (Method of Alignment-wise marking using chainage), compaction of embankments, construction methods and field control checks for various types of flexible pavement materials in sub-base, base, binder and surface course layers; Construction procedure of Low Volume Rigid Pavement.	**10 L**
Module 3	**Pavement Evaluation:** Pavement Distress Functional condition evaluation of pavements- Roughness, Skid Resistance, Serviceability Index; Structural evaluation of pavements – Benkelman beam and Falling Weight Deflectometer; Pavement strengthening; Design of bituminous and concrete overlays as per IRC	**10 L**
Module 4	**Sustainability:** Scope of adoption of sustainable construction techniques by using recyclable hazardous materials- fly ash, plastics, recyclable construction materials.	**3 L**

Reference

Sl.	Book Name	Author	Publishing House
1	Highway Engineering	Khanna, Justo and Veeraghavan	Nem Chand and Bros.
2	Principles of Pavement Design	C.J Khisty & B.K Lall.	Prentice Hall India
3	Principles of Transportation Engineering	Yang H. Huang	Pearson
4	Highway Engineering	L.R. Kadiyali	Prentice Hall India
5	I.S Specifications on Concrete Aggregate & Bitumen	Bureau of Indian Standard	
6	Relevant latest IRC Codes (IRC-37 – 2001, IRC 58 – 2002, IRC 73 - 1980, IRC 86 - -1983, IRC 106 – 1990, IRC 64 – 1990, IRC 15- 2002	Indian Roads Congress	

PE-CE701C	ADVANCED FOUNDATION ENGINEERING	3 L	3 Credits
Course Outcome	**After going through this course, the students will be able to:** 1. Identify a suitable foundation system for a structure. 2. Evaluate the importance of raft foundation and principles of 3. Design for buildings and tower structures. 4. Analyse and design pile foundations. 5. Examine and discuss various machine foundations. 6. Analyse and design Sheet piles and cofferdams.		
Prerequisite	Foundation Engineering PC-CE605		
Module 1	**Soil Exploration and Site Investigation:** Planning of soil exploration programme, Field testing, Preparation of bore-log and soil investigation report. **Geo-physical exploration:** Seismic refraction survey electrical resistively method.		4 L
Module 2	**Shallow Foundations:** Bearing Capacity from SPT and SCPT and Plate load Test data, Proportioning of footing based on settlement criteria. **Beams on elastic foundation:** Infinite beam, Finite beam, Modulus of sub-grade reaction and effecting parameters. **Raft Foundation:** Settlement and Bearing Capacity analysis, Analysis of flexible and rigid raft as per IS 2950.		10 L
Module 3	**Deep Foundations:** **Pile:** Tension piles, Laterally loaded piles: Elastic continuum approach, Ultimate load Analysis, Deflection and maximum moment as per IS 2911, Pile load test. **Drilled Shaft:** Construction procedures, Design Considerations, Load Carrying Capacity and settlement analysis. **Caissons:** Types, Sinking and control.		8 L
Module 4	**Retaining walls and sheet pile structures**: Gravity, cantilever and counter fort retaining walls: Stability checks and design. **Sheet Pile Structures:** Cantilever sheet piling, Anchored sheet piling: Free and fixed earth support methods of Analysis, Braced Excavation.		8 L
Module 5	**Design of foundation for vibration control:** Elements of vibration theory, Soil- springs and damping constants, dynamic soil parameters, Types of Machine foundations, General consideration in designing dynamic bases.		4 L
Module 6	**Foundations on expansive soils:** Problems and Remedies		2 L

Reference	Sl.	Book Name	Author	Publishing House
	1	Foundation Analysis & Design	J.E. Bowels	McGraw Hill
	2	Principles of Foundation Engineering	B.M. Das	Thomson Book
	3	Foundation Design Manual	N. V. Nayak	Dhanpat Rai Publication Pvt. Ltd
	4	Foundations for Machines: Analysis and design	Shamsher Prakash, Vijay K Puri	Wiley Series in Geotechnical Engineering

	5	Advance Foundation Engineering	N. Som& S. C. Das	
	6	Hand Book of Machine Foundation	P. Sirinivashalu & C.V. Vaiddyanathan	Tata McGraw Hill
		IS –1904, 6403, 8009, 2950, 2911 etc		Bureau of Indian Standard

PE-CE702A	**PRE-STRESSED CONCRETE**	2L	2 CREDITS
Course Outcome	After going through this course, the students will be able to: 1. Learn the introduction of Pre-stressed concrete member and its deflection properties 2. Develop the design criteria of Pre-stressed concrete section for flexure and shear properties 3. Analyze the anchorage zone stress for post-tensioned members 4. Impart knowledge regarding the methods of Analysis of Statically Indeterminate Structures. 5. Impart knowledge regarding the composite construction of Prestress and In-situ concrete. 6. Impart knowledge regarding Design of Pre-stressed concrete poles and sleepers and introduction of partial prestressing.		
Prerequisite	Solid Mechanics (ES-CE401), Structural Analysis – I (PC-CE502), Design of RCC Structures (PC-CE501), Structural Analysis II (PC-CE606)		
Module 1	**Introduction of Pre-stressed concrete:** Materials, prestressing system, analysis of prestress and bending stress, losses Shear and torsional resistance: design of shear reinforcement, design of reinforcement for torsion shear and bending. **Deflections of Pre-stressed concrete members:** Importance, factors, short term and long term deflection		8L
Module 2	**Shear and Torsional Resistance:** Design of Shear Reinforcement, Design of Reinforcement for Torsion, Shear and Bending. **Limit State Design Criteria:** Inadequacy of Elastic and Ultimate Load Method, Criteria for Limit States, Strength and Serviceability. **Design of Pre-stressed Concrete Section:** for Flexure & methods by Lin and Magnel		8L
Module 3	**Anchorage Zone stresses in post tensioned members:** Stress distribution in end block, anchorage zone reinforcement		3L
Module 4	**Statically Indeterminate Structures:** Advantages of Continuous Member, Effect of Prestressing, Methods of Achieving Continuity and Method of Analysis of Secondary Moments		4L
Module 5	**Composite Construction of Pre-stressed and In-situ Concrete:** Types, Analysis of Stresses		3L
Module 6	**Pre-stressed Concrete Poles and Sleepers:** Design of Sections for Compression and Bending. Introduction to Partial Prestressing.		2L

IS Codes	**1**	IS: 1343 : 2012		
Reference	**Sl.**	**Book Name**	**Author**	**Publishing House**
	1	Pre-stressed Concrete	N. Krishna Raju	TMH
	2	Pre-stressed Concrete	Ramamuthram	Dhanpat Rai Publishing Company
	3	Fundamentals of Pre-stressed Concrete	N.C. Sinha and S. K. Roy	S. Chand
	4	Pre-stressed Concrete	Karuna Moy Ghosh	PHI
	5	Design of Pre-stressed Structures	T. Y. Lin and N. H. Burns	

<table>
<tr><td>PE-CE702A</td><td colspan="2">FINITE ELEMENT METHOD</td><td>2L</td><td>2 Credits</td></tr>
<tr><td>Course Outcome</td><td colspan="4">After going through this course, the students will be able to:
1. Obtain an understanding of the fundamental theory of the FEA method.
2. Develop the ability to generate the governing FE equations for systems governed by partial differential equations.
3. Understand the use of the basic finite elements for structural applications using truss, beam, frame, and plane elements.</td></tr>
<tr><td>Prerequisite</td><td colspan="4">Basic Mathematics</td></tr>
<tr><td>Module 1</td><td colspan="3">Introduction to Finite Element Analysis:
Basic Concepts of Element Analysis and its necessity.</td><td>5L</td></tr>
<tr><td>Module 2</td><td colspan="3">Numerical tools for Finite Element Formulation:
Variational Principle: Ritz method, Weighted residual method: Galerkin approach, Petrov-Galerkin approach.</td><td>8L</td></tr>
<tr><td>Module 3</td><td colspan="3">Finite element Formulation:
Formulation of Euler-Bernoulli beam element and Timoshenko beam element, Imposition of boundary conditions.</td><td>8L</td></tr>
<tr><td>Module 4</td><td colspan="3">Elements and their properties:
One dimensional and two-dimensional elements (Bar element, Beam element, Plate element), Interpolation functions, Numerical integration.</td><td>8L</td></tr>
<tr><td>Module 5</td><td colspan="3">Finite element solutions:
Formulation of stiffness matrix and solution of beam, plate and truss problems, Problems on Plates with cutout.
Introduction to the software SAP.</td><td>5L</td></tr>
<tr><td rowspan="8">Reference</td><td>Sl.</td><td>Book Name</td><td>Author</td><td>Publishing House</td></tr>
<tr><td>1</td><td>An Introduction to the Finite Element Method</td><td>Reddy J. N</td><td>McGraw Hill Publication</td></tr>
<tr><td>2</td><td>Matrix and Finite Element Analyses of Structures</td><td>Mukhopadhyay</td><td>Oxford and IBH Publishing Co. Pvt. Ltd</td></tr>
<tr><td>3</td><td>Concepts and Applications of Finite Elements Analysis</td><td>Cook R.D, Malkus, Plesha and Witt</td><td>Wiley</td></tr>
<tr><td>4</td><td>Finite Element Analysis: Theory and Programming</td><td>Krishnamoorty C. S.</td><td>McGraw Hill Publication</td></tr>
<tr><td>5</td><td>Introduction to Finite Elements in Engineering</td><td>Chandrupatla and Belegundu</td><td>PHI</td></tr>
<tr><td>6</td><td>Finite Element Method with Applications in Engineering</td><td>Desai</td><td>Pearson</td></tr>
<tr><td>7</td><td>Finite Element Procedures</td><td>Bathe</td><td>PHI</td></tr>
</table>

PE-CE702C	**REPAIR & REHABILITATION OF STRUCTURES**	**2L**	**2 Credits**
Course Outcome	**On completion of the course the students will be able to:** 1. Various distress and damages to concrete and masonry structures 2. The importance of maintenance of structures, types and properties of repair materials etc 3. Assessing damage to structures and various repair techniques		
Prerequisite	Solid Mechanics [CE(ES)401], Structural Analysis – I [CE(PC)502], Design of RC Structures [CE(PC)501], Concrete Technology [CE(PC)401].		
Module 1	**Introduction:** Overview of distress, deterioration in concrete structures, Scenario of distressed structures world over, Need for repairs and upgrading of structures, General introduction to process (Road-map) to a durable concrete repair.		**3L**
Module 2	**Deterioration of concrete structures:** Types of deterioration – Signs, causes & symptoms, Mechanism of deterioration, contributing factors like permeability, inadequate durability & micro-structure of concrete. Physical deterioration due to moisture, temperature, shrinkage, freeze-thaw, abrasion, erosion, cavitation, crystallization of salts, Efflorescence, exposure to severe environment like marine exposure. Chemical deterioration due to corrosion of reinforcement (chloride induced, carbonation induced), Alkali-silica reaction, sulphate attack, Acid attack Deterioration due to water leakage, fire – detection & mitigation of the same. Deterioration due to ageing, inadequate maintenance, Design & construction deficiencies, overloading etc. Types of cracks, causes & characteristics of cracking in various structural components like beam, column, slab, masonry walls. Measurement of cracks, interpretation of the cause of particular type of crack.		**9L**
Module 3	**Conditional/damage assessment & Evaluation of structures:** Structural assessment: Conditional evaluation / Structural Appraisal of the structure – Importance, objective & stages, Conditional/damage assessment procedure, Preliminary & Detailed investigation – Scope, Objectives, Methodology & Rapid visual inspection of structures **Damage Assessment allied Tests (Destructive, Semi-destructive, Non-destructive):** Field & laboratory testing procedures for evaluating the structure for strength, corrosion activity, performance & integrity, durability. Interpretation of the findings of the tests		**9L**
Module 4	**Repairs, rehabilitation & Retrofitting of concrete structures:** Repair materials - Criteria for durable concrete repair, Methodology, performance requirements, repair options, selection of repair materials, Preparatory stage of repairs, Different types of repair materials & their application, types of repair techniques. **Retrofitting/Strengthening:** Need for retrofitting, Design philosophy of strengthening structures, Techniques available for strengthening including conventional and advanced techniques. Seismic retrofit of concrete structures: Deficiencies in structure requiring seismic retrofit, Design philosophy, Techniques to enhance the seismic resistance of structures, advanced techniques for making seismic resistant structures		**9L**

Module 5	**Protection & maintenance of structures -** Importance of protection & maintenance, Categories of maintenance, Building maintenance. Corrosion mitigation techniques to protect the structure from corrosion. **Long term health monitoring / Structural health monitoring (SHM)–** Definition and motivation for SHM, Basic components of SHM and its working mechanism, SHM as a tool for proactive maintenance of structures.	**4L**

	Sl.	**Book Name**	**Author**	**Publishing House**
Reference	1	Handbook on repair and rehabilitation of RCC buildings	CPWD, Government of India	
	2	Failures and repair of concrete structures	S. Champion	John Wiley and Sons
	3	Diagnosis and treatment of structures in distress	R. N. Raikar	R & D Centre of Structural Designers and Consultants Pvt. Ltd
	4	Handbook on seismic retrofit of buildings	A. Chakrabarti et.al	Narosa Publishing House
	5	Repair and protection of concrete structures	Noel P. Mailvaganam	CRC Press
	6	Concrete repair and maintenance	Peter. H. Emmons	Galgotia publications
	7	Maintenance, Repair & Rehabilitation and Minor works in Building	P.C. Varghese	PHI
	8	Concrete Structures Repair Rehabilitation and Retrofitting	J Bhattacharjee	CBS
	9	Repair & Rehabilitation of Concrete Structures	Modi and Patel	PHI

PE-CE703A	AIR AND NOISE POLLUTION AND CONTROL	2L	2 credits
Course outcome	**After going through this course, the students will be able to:** 1. Define the basic concepts and terminologies regarding air pollution and noise pollution 2. Describe the physics of air pollution and noise pollution 3. Apply the methods of air pollution and noise pollution measurements 4. Analyze different concepts of air and noise pollution solving mathematical problems 5. Compare air and noise quality with allowable standards and limits 6. Choose and design proper techniques for air pollution control and noise pollution control		
Prerequisite	Class-XII level knowledge of Physics, Chemistry, Mathematics, Biology and Environmental Science; Undergraduate level knowledge of Statistics and Environmental Engineering		
Module 1	**Air Pollutants** Sources; Classification; Effects on Human, Vegetation, Material Effects of Air pollution on Atmosphere: Photochemical Smog, Ozone Layer Depletion, Acid Rain, Greenhouse Effect and Global Warming		**4L**
Module 2	**Air Pollution Meteorology** Lapse Rate; Atmospheric Stability; Inversion; Plume Pattern		**3L**
Module 3	**Dispersion of Air Pollutants** Point Source Gaussian Plume Model, Stability Classes, Stability Charts, Design of Stack Height		**3L**
Module 4	**Air Quality** Methods of Measurement**:** Gaseous pollutants, Particulate pollutants Air Quality Standards and Indices: Ambient Air Quality Standard, NAAQS, Emission Standard, Air Quality Indices		**4L**
Module 5	**Air Pollution Control** Control of Gaseous Pollutants: Adsorption, Absorption, Condensation Control of Particulate Pollutants: Settling chambers, Cyclone separators, Wet collectors, Fabric filters, Electrostatic precipitators Control of Pollution from Automobiles		**6L**
Module 6	**Physics of Noise** Basics of Acoustics; Sound Pressure, Power and Intensity and their Interrelations		**2L**
Module 7	**Measurement of Noise** Noise Level; Interrelation between Noise, Pressure, Power and Intensity Levels; Noise Meter; Noise Networks; Frequency Band Analysis; Decibel Addition Measurement of Community Noise: LN, L_{eq}, L_{dn},, L_{NP}		**6L**

Module 8	**Source and Effect of Noise** Psychoacoustics and noise criteria; effects of noise on health; annoyance rating schemes			**2L**
Module 9	**Noise Pollution Control** Noise Standards and Limits; Methods of Noise Pollution Control			**4L**
Reference	1	Environmental Engineering. Volume-1 and Volume-2	Garg, S.K.	Khanna Publishers
	2	Environmental Engineering: A Design Approach.	Sincero, A., Sincero, G.	Prentice Hall
	3	Introduction to Environmental Engineering and Science	Masters, G.M., Ela, W.P.	Prentice Hall / Pearson
	4	Air Pollution	Rao, M.N., Rao, H.V.N.	Tata McGraw Hill

PE-CE703B	PHYSICO-CHEMICAL PROCESSES FOR WATER AND WASTEWATER TREATMENT	2L	2 Credits
Course Outcome	**After going through this course, the students will be able to:** 1. Define the basic concepts and terminologies regarding physico-chemical treatment of water and wastewater 2. Describe the physics, chemistry and hydraulics of different unit operations and processes for water and wastewater treatment 3. Analyze different physico-chemical water and wastewater treatment options solving mathematical problems 4. Design different physico-chemical treatment processes to treat water and wastewater		
Prerequisite	Class-XII level knowledge of Physics, Chemistry, Mathematics, Biology and Environmental Science; Undergraduate level knowledge of Engineering Statistics, Engineering Physics, Engineering Chemistry, Fluid Mechanics and Hydraulics and Environmental Engineering		
Module 1	**Introduction and Basic Concepts:** Water purification in natural systems, physical processes, chemical processes and biological processes; Primary, secondary and tertiary treatment; Unit operations, unit processes		2L
Module 2	**Aeration:** Aeration and Gas Transfer		2L
Module 3	**Plain Sedimentation:** Sedimentation, different types of settling; sedimentation tank design		3L
Module 4	**Clariflocculation:** Coagulation and flocculation; Coagulation processes, Stability of colloids; Destabilization of colloids; Destabilization in water and wastewater treatment; Transport of colloidal particles; Design aspects		4L
Module 5	**Filtration:** Filtration processes; Hydraulics of flow through porous media; Rate control patterns and methods; Filter effluent quality parameters; Mathematical model for deep granular filters; Slow sand filtration, Rapid sand filtration, Pressure filtration; design aspects		4L
Module 6	**Disinfection:** Types of disinfectants; Kinetics of disinfection; Chlorination and its theory; Design of Chlorinators		3L
Module 7	**Precipitation:** Hardness removal; Iron, Manganese, and Heavy metal removal		3L
Module 8	**Adsorption:** Adsorption equilibria and adsorption isotherm; Rates of adsorption; Sorption kinetics in batch reactors; Continuous reactors; Factors affecting adsorption		3L
Module 9	**Ion Exchange Processes:** Materials and reactions; Methods of operation; Application; Design aspects		3L
Module 10	**Membrane Processes:** Reverse osmosis, Ultrafiltration, Electro-dialysis		3L

Reference	Sl.	Book Name	Author	Publishing House
	1	Environmental Engineering	Peavy, Rowe and Tchobanoglous	Tata McGraw Hill Indian Edition
	2	Theory and Practices for Water and Wastewater Treatment	Ronald L Drsote	Wiley Publishers

	3	Manual of Water Supply & Treatment		A Government of India Publication.
	4	Environmental Engineering. Volume-1	S.K. Garg	Khanna Publishers
	5	Water Quality and Treatment: A Handbook of Community Water supplies		American Water Works Association
	6	Water Quality and Treatment	S.C. Sharma	Khanna Publishing House

PE-CE703C	**WATER AND AIR QUALITY MODELLING**	**2L**	**2 Credits**
Course Outcome	On completion of the course the students will be able to: 1. Define the basic concepts and terminologies regarding water and air quality modelling 2. Describe the background mechanisms in modelling water and air quality 3. Analyse different water and air quality models solving mathematical problems 4. Apply the concepts of air and water quality modelling in air and water pollution control and management		
Prerequisite	Class-XII level knowledge of Physics, Chemistry, Mathematics, Biology and Environmental Science; Undergraduate level knowledge of Engineering Statistics, Engineering Physics, Engineering Chemistry, Fluid Mechanics and Hydraulics and Environmental Engineering		
Module 1	**Introduction to Water Quality Models** Introduction to mathematical models; Water quality model development; Calibration and verification; Cost benefit analysis using models; Model requirements and limitations		**3L**
Module 2	**Dissolved Oxygen Model for Streams** Sources and sinks of dissolved oxygen; Estimation of system parameters; Streeter Phelps model, oxygen 'sag' curve, Determination of deoxygenation and re-aeration coefficients; Benthal oxygen demand; Mass transport mechanisms		**6L**
Module 3	**Models for Estuary and Lakes** Physical chemical and biological processes in estuaries and lakes		**3L**
Module 4	**Introduction to Air Quality Models** Micrometeorological processes, Wind rose, Dispersion, coefficients and Stability classes		**4L**
Module 5	**Dispersion Models** Point Source Gaussian Dispersion Model, Stack height computation; Line Source Models; Box Models		**4L**
Module 6	**Air Quality Models** Regional air quality models, Source inventories and significance		**4L**

Reference	Sl.	Book Name	Author	Publishing House
	1	Air Pollution and Control	Keshav Kant, Rajni Kant	Khanna Publishing House
	2	Elements of Water Pollution Control Engineering	O.P. Gupta	Khanna Publishing House
	3	Environmental Engineering	S.C. Sharma	Khanna Publishing House
	4	Environmental Engineering. Volume-1 and Volume-2.	Garg, S.K.	Khanna Publishers
	5	Environmental Engineering	Peavy, H.S, Rowe, D.R, Tchobanoglous, G	Tata McGraw Hill Indian Edition
	6	Introduction to Environmental Engineering and Science.	Masters, G.M., Ela, W.P.	Prentice Hall /Pearson

PE-CE703A	**STRUCTURAL DYNAMICS AND EARTHQUAKE ENGINEERING**	**2L**	**2 credits**
Course outcome	**After going through this course, the students will be able to:** 1. Fundamental theory of dynamic equation of motion 2. Fundamental analysis methods for dynamic systems 3. Dynamic properties and behavior of civil engineering structures 4. Modelling approach to obtain dynamic responses in civil engineering applications. 5. Principles of earthquake resistant design of RCC building structures. 6. Fundamental concepts of ductile detailing of RCC building structure components.		
Prerequisite	Solid Mechanics [ES-CE401], Structural Analysis – I [PC-CE502], Structural Analysis – II [PC-CE606], and Engineering Mathematics		
Module 1	**Basics of Structural Dynamics:** Introduction of Structural Dynamics, Differential Equations in Civil Engineering, Types of Analysis, Static and Dynamic loads, Damping, Degrees of Freedom, Dynamic Equilibrium Equation.		**4L**
Module 2	**Free Vibration of SDOF:** Undamped free Vibration, Natural Period/Frequency, Energy in Free Vibration, Damped Free Vibration, Types of damping, Logarithmic decrement equation **Forced Vibration of SDOF:** Undamped Forced vibration, Amplitude & Phase Angle, Dynamic amplification factor for deflection (R_d), Damped Forced vibration, Relationship between R_d, R_v and R_a		**6L**
Module 3	**Force Transmission, Isolation and Vibration Measurement:** Resonant frequency and Half power band width, Force Transmission and Isolation, Design of Vibration Measuring Instruments		**4L**
Module 4	**Response to Arbitrary Excitations:** Response to Unit Impulse, Response to Arbitrary Force (Duhamel's Integral), Response to Step and Ramp Forces, Response to Rectangular Pulse, Half Sinusoidal wave, Introduction to numerical evaluation of Duhamel's integral of undamped system, Fourier series analysis.		**6L**
Module 5	**Multi-Degree of Freedom Systems:** Equation of Motion for MDOF System, Solution of Equation, Natural Frequencies and mode Shapes, Modal Orthogonality, Approximate Method for finding Natural frequency.		**4L**
Module 6	**Generalized Coordinates and Rayleigh's Method:** Principles of Virtual work, Generalized SDOF system- Rigid body, Distributed elasticity, Rayleigh's method**.**		**3L**
Module 7	**Elements of seismology: Fundamentals:**		**3L**

	Elastic rebound theory, Plate tectonics, Definitions of magnitude, Intensity, Epicenter etc., Seismographs, Seismic zoning etc.			
Module 8	**Principles of earthquake resistant design:** Terminology, General principles and Design criteria, Methods of Analysis, Equivalent lateral force method of Analysis for multi-storeyed building as per Indian Standard Code of Practice, Modal analysis and Response Spectrum Method, Fundamental concepts of Ductile detailing.			**8L**
	Sl. No.	**Book Name**	**Author**	**Publisher**
References	1	Structural Dynamics (Theory and Computation)	Mario Paz.	CBS Publishers
	2	Dynamics of Structure (Theory and Application to Earthquake Engineering)	A. B. K. Chopra	Pearson Education
	3	Dynamics of Structures	Ashok K. Jain	Pearson Education

PE-CE704B	ADVANCE STRUCTURAL ANALYSIS	2L	2 credits
Course outcome	**After going through this course, the students will be able to:** 1. Basic Knowledge of the student will increase. 2. Student will be able to apply stiffness and flexibility method using system approach. 3. Student will understand the yield conditions from their knowledge of stress-strain relations. 4. Student will be able to solve simple plate and shell problems		
Prerequisite	Solid Mechanics [ES-CE401], Structural Analysis – I [PC-CE502], Structural Analysis – II [PC-CE606], and Engineering Mathematics		
Module 1	**Matrix methods of structural analysis:** Application of matrix methods to plane truss, beams, continuous frames.		**9L**
Module 2	**Finite difference and relaxation technique:** Application to simple problems.		**6L**
Module 3	**Theory of plate bending:** Navier's Solutions, Levy's solution, Plate buckling problem. Membrane theory of domes and cylindrical shells.		**7L**
Module 4	**Theory of Elasticity:** Three dimensional stress and strain analysis, stress strain transformation, stress invariants, equilibrium and compatibility equations. Two dimensional problems in Cartesian and polar coordinates. Plane stress, plane stain problems, St. Venant's principle.		**6L**

Reference	Book Name	Author	Publisher
1	Matrix, finite element, computer and structural analysis,	Mukhopadhyay	ANE Books
2	Intermediate Structural analysis	Wang	Mc Graw Hill
3	Theory of Plates and Shells	Timoshenko & Krieger	Mc Graw Hill
4	Theory of Elasticty	Timoshenko & Goodier	Mc Graw Hill
5	Analysis of Structures	T.S. Thandavamoorthy	Oxford University Press

JALPAIGURI GOVERNMENT ENGINEERING COLLEGE
(NAAC ACCREDITED AUTONOMOUS INSTITUTE)
DEPARTMENT OF CIVIL ENGINEERING

PE-CE704C	INDUSTRIAL STRUCTURE	2L	2 credits
Course outcome	**After going through this course, the students will be able to:** 1. To perform the analysis and design of reinforced concrete members and their connections. 2. To identify and apply the industrial design codes relevant to the design of Reinforced concrete members. 3. To be familiar with the professional and contemporary design issues and fabrication of Reinforced concrete members.		
Prerequisite	Solid Mechanics [ES-CE401], Structural Analysis – I [PC-CE502], Structural Analysis – II [PC-CE606]		
Module 1	**Overall Review of RC Design:** Review of Limit State Design of Beams, Slabs & Columns according to IS 456-2000. Yield line theory, Biaxial Bending & Slander Column. **Analysis and Design of beams curved in plan:** Design principle, structural design of beams curved in plan of circular and rectangular types. **Flat slabs:** Introduction, components – IS code provisions Design method –Design for flexure and shear and Detailing.		**8L**
Module 2	**Deep beams:** Introduction, Flexural and shear stresses in deep beam and Design and Detailing. **Water tank:** Introduction, Types, Analysis and Design of water tanks e.g. Underground & Elevated water tank (Circular, Rectangle and Intz)		**7L**
Module 3	**Raft Foundation:** Introduction, Types and Design of raft foundation. **Design of folded plate** **Design of shear wall as per IS 13920**		**7L**
Module 4	**Design of bunkers and silos:** Introduction, Difference between Bunkers and Silo (rectangular, square and circular bunker and silo design for storage of cement). **Analysis and design of chimneys:** Introduction and different types of linings, wind load calculation on chimney (Static and dynamic) Analysis and design of chimney linings, foundation types.		**8L**

Reference	**Sl.**	**Book Name**	**Author**	**Publishing House**
	1	R.C.C. Design	B.C. Punmia	Laxmi Publication
	2	Reinforced concrete structures	N. Subramanian	OXFORD University Press
	3	Advanced Reinforced Concrete Design	P. C. Varghese	PHI
	4	Advanced Reinforced Concrete Design	N. KrishnaRaju	CBS Publishers

IS Codes		
	1	IS: 456 – 2000 (latest revision)
	2	IS 875 – I (1987), II (1987), -III (2015), -IV(1987), V (1987)
	3	SP: 16 Design Aid to IS 456
	4	IS 1893-Part-I: 2016, IS 1893-Part-II: 2014
	5	IS 3370 –I (1967), II (2009), III (1967), IV (1967)

PE-CE705C	BRIDGE ENGINEERING	2L	2 Credits
Course Outcome	**After going through this course, the students will be able to:** 1. Discuss basic definitions, types, and components of bridges. 2. Discuss sub-surface investigations required for bridge construction. 3. Understand standard specification and loads for bride design. 4. Perform design of different types of bearings and joints for bridges. 5. Perform design of various reinforced concrete and steel bridges.		
Prerequisite	Design of RC Structures [PC-CE5401], Structural Analysis – I [PC-CE502], Design of Steel Structures [PC-CE604],		
Module 1	**Introduction:** Definition and basic forms, components of a typical bridge, classification of bridges, site investigation, bridge hydrology and hydraulics. **Loads:** I.R.C loads, impact factors, wind loads, longitudinal forces, lateral forces and centrifugal forces. **Bearings:** Types of bearings, details of bearing, joints, design examples.		3L
Module 2	**Design of reinforced concrete solid slab bridge:** Introduction, general design features, economic span, effective width method, simply supported and cantilever slab bridges, analysis and design.		7L
Module 3	**Design of box culvert bridge:** Introduction, design method and design example.		4L
Module 4	**Design of a T beam bridge:** Introduction, components, design of interior panel of slab, longitudinal and cross girders, Pigeaud's method, and design example.		6L
Module 5	**Design of composite bridge:** General aspects, method of construction, analysis of composite section, shear connectors, design of composite beam.		4L
Module 6	**Design of cable stayed bridge:** General features, Philosophy of design.		6L
Module 7	**Design of cable stayed bridge:** General features, Philosophy of design.		2L

Reference

Sl.	Book Name	Author	Publishing House
1	Prestressed Concrete Bridges	N. Krishnaraju	CBS Publisher
2	Design of Bridge Structures	Jagadish and Jayaram	PHI
3	Essential Bridge Engineering	Jhonson Victor D.	Oxford, IBH Publishing Co.
4	Design of Bridges	N. Krishnaraju	Oxford, IBH Publishing Co.
5	Concrete Structures	Vazirani & Ratwani	Khanna Publishers
6	Design of concrete bridges	Aswani, Vazirani & Ratwani	Khanna Publishers
7	Bridge engineering	Ponnuswamy	McGrawHill
8	Principle & Practice of Bridge Engineering	Bindra	Dhanpat Rai Publishing House
9	All relevant IRC and IS codes.		

<table>
<tr><td>PE-CE705B</td><td colspan="2">URBAN TRANSPORTATION PLANNING</td><td>2L</td><td>2 Credits</td></tr>
<tr><td>Course Outcome</td><td colspan="4">After going through this course, the students will be able to:
1. Urban morphology
2. Advantages and disadvantages of urban transportation system
3. To design urban transportation system
4. To apply ICT to improve urban transportation system</td></tr>
<tr><td>Prerequisite</td><td colspan="4">Class-XII level knowledge of Physics, Mathematics and Mechanics; Undergraduate level knowledge of Engineering Statistics, Engineering Physics, Soil Mechanics- I [ES-CE401] and Transportation Engineering [PC-CE505]</td></tr>
<tr><td>Module 1</td><td colspan="3">Introduction Urban morphology:
Urbanization and travel demand – Urban activity systems and travel patterns – Systems approach – Trip based and Activity based approach</td><td>4L</td></tr>
<tr><td>Module 2</td><td colspan="3">Urban Transportation Planning:
Goals, Objectives and Constraints - Inventory, Model building, Forecasting and Evaluation - Study area delineation – Zoning - UTP survey. Trip generation models – Trip classification - productions and attractions – Trip rate analysis - Multiple regression models - Category analysis. Trip distribution models – Growth factor models, Gravity model and Opportunity modes. Modal split models – Mode choice behavior – Trip end and trip interchange models - Probabilistic models – Utility functions - Logit models - Two stage model. Traffic assignment – Transportation networks – Minimum Path Algorithms - Assignment methods – All or Nothing assignment, Capacity restrained assignment and Multi path assignment - Route-choice behavior</td><td>21L</td></tr>
<tr><td>Module 3</td><td colspan="3">Scope of UTP in present scenario:
Financing of Project – urban development planning policy - Case studies</td><td>5L</td></tr>
<tr><td rowspan="6">Reference</td><td>Sl.</td><td>Book Name</td><td>Author</td><td></td></tr>
<tr><td>1</td><td>Transportation Engineering</td><td>L.R. Kadiyal</td><td></td></tr>
<tr><td>2</td><td>Traffic Engineering and Transport Planning</td><td>L.R. Kadiyal</td><td></td></tr>
<tr><td>3</td><td>Urban Transportation: Planning, Operation and Management</td><td>S Ponnuswamy and Johnson Victor</td><td></td></tr>
<tr><td>4</td><td>I.S Specifications on Concrete Aggregate & Bitumen</td><td>Bureau of Indian Standard</td><td></td></tr>
<tr><td>5</td><td>Relevant latest IRC Codes (IRC-37 – 2001, IRC 58 – 2002, IRC 73 - 1980, IRC 86 - - 1983, IRC 106 – 1990, IRC 64 – 1990, IRC 15- 2002</td><td>Indian Roads Congress</td><td></td></tr>
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<table>
<tr><td>PE-CE705C</td><td colspan="2">RAILWAY AND AIRPORT ENGINEERING</td><td>2L+0T</td><td>2 credits</td></tr>
<tr><td>Course outcome</td><td colspan="4">On completion of the course the students will be able to:
1. Explain the basics in planning functional components of Railway and Airport.
2. Illustrate the engineering concepts of construction, operation and maintenance of Railway and Airport components.
3. Interpret the geometric design parameters of Railway
4. Decide the runway orientation of proposed runway on the basis of previous wind data analysis
5. Assess the basic runway length parameters.</td></tr>
<tr><td>Prerequisite</td><td colspan="4">Class-XII level knowledge of Physics, Mathematics; Undergraduate level knowledge of Strength of Materials.</td></tr>
<tr><td>Module 1</td><td colspan="3">Railway Engineering
Introduction to Railway Engineering: Socio-economic impact of Indian Railways; Zonal classification of Indian Railways; Railway track gauge; Classification of Indian Railways based on Speed Criteria.
Permanent Way (P-way): Components – Rails, Rail joints,Sleepers, Ballast, Fastenings, Sub-grade.
Track Alignment and Engineering Survey: Basic requirement of good alignment; Factors in selection of good alignment; Engineering Survey.
Track Stresses.
Geometric Design: Gradient, Speed, Degree of Curve, Super-elevation, Transition curve, Widening of gauge on curves, Shift.
Points and Crossings; Station and Yards; Signalling and Control Systems.</td><td>20L</td></tr>
<tr><td>Module 2</td><td colspan="3">Airport Engineering
Airport Site Selection; Airport layout; Functions and planning of the Airfield components – runway, taxiway and Aprons, hanger, terminal building and control tower;
Design of Runway and Taxiway;
Runway orientation: Windrose diagrams</td><td>10L</td></tr>
<tr><td rowspan="5">Reference</td><td>Sl No</td><td>Book Name</td><td>Author</td><td>Publisher</td></tr>
<tr><td>1</td><td>A Textbook of Railway Engineering</td><td>Saxena S.P. & Arora S.P</td><td>Dhanpat Rai & Sons</td></tr>
<tr><td>2</td><td>Indian Railway Track</td><td>Agarwal M.M</td><td>Sachdeva Press</td></tr>
<tr><td>3</td><td>Airport Planning & Design</td><td>KhannaS.K , Arora M.G & Jain S.S.</td><td>Nemchand Brothers</td></tr>
<tr><td>4</td><td>Planning & Design of Airports</td><td>Horonjeff R &Mckelvey F</td><td>Mc. Graw Hill.</td></tr>
</table>

PE-CE801A	COMPUTATIONAL HYDRAULICS	3L	3 credits
Course outcome	**After going through this course, the students will be able to:** 1. Identify the complexities involved in fluid flow problems. 2. Model the specific flow problem in terms of defining the governing equations, initial and boundary conditions and appropriate solution schemes to use. 3. Develop finite difference formulation of ordinary and partial differential equations of flow problems. 4. Develop finite volume formulation of ordinary and partial differential equations of flow problems.		
Prerequisite	Fluid Mechanics & Hydraulic Machines [ES-CE301], Water Resources Engineering [PC-CE603]		
Module 1	**Introduction:** Modelling Theory - Physical modelling, analytical modelling, numerical modelling; classification of models based on i) Scale (space and time), ii) Solution (analytical and numerical); Concept of computational hydraulics; Processes involved in model development and application.		4L
Module 2	**Modelling Fluid Flow Problems:** Governing equations-Conservation of mass, conservation of momentum, conservation of energy; Mathematical classification of flow equations, solution of ordinary differential equations and partial differential equations, boundary conditions; Solution of Saint-Venant Equations - Kinematic wave solution,Diffusive wave solution and full dynamic solution; Characteristic form of Saint-Venant Equations.		8L
Module 3	**Numerical Solution Schemes:** Discrete solution of governing equations, Space discretization - Structured grids and unstructured grids, grid generation, time discretization.		2L
Module 4	**Finite Difference Method:** General concept, approximation of derivatives; Finite difference formulation for ordinary differential equations – Explicit schemes, Implicit schemes, Mixed schemes and weighted average schemes; Finite difference formulation for partial differential equations - initial conditions, boundary conditions, explicit and implicit schemes; The Preissmann Scheme, The Abbott-Ionescu scheme.		8L
	Example Applications: Ordinary differential equation - Solution of linear reservoir problem; Partial differential equation - Solution of simple wave propagation, Solution of diffusion equation.		6L
Module 5	**Finite Volume Method:** General concept, Steps in		8L

	application of Finite Volume Method- Surface and volume integrals, Discretization of convective fluxes, Discretization of diffusive fluxes, evaluation of time derivative, boundary conditions.	
	Example Application: Solution of Advection-Diffusion Equation in 1-D.	**4L**
Reference	1. Computational Hydraulics, M. B. Abbott and A. W. Minns, Routledge, London, 2016 2. Computational Hydraulics – An Introduction, C. B. Vreugdenhil, Springer – Verlag, New York, 1989 3. Computational Hydraulics, C. A. Brebbia and A. J. Ferrante, Butterworth-Heinemann, 2013. 4. Computational Methods for Fluid Dynamics, J. H. Ferziger and M. Peric Springer, London, 2002.	

PE-CE801B	HYDRAULIC STRUCTURES	3L	3 credits
Course outcome	**After going through this course, the students will be able to:** 1. Identify the characteristics of various types of dams and their selection procedure. 2. Perform the reconnaissance survey and, geophysical investigations necessary for selection of suitable dam site 3. Estimate forces acting on a gravity dams and perform stability analysis. 4. Estimate the seepage loss through embankment dams and suggest necessary remedial measures. 5. Calculate the discharge through the overflow section and design the appropriate energy dissipation structures.		
Prerequisite	Water Resources Engineering [PC-CE603]		
Module 1	**Storage Structures:** Dams, Types of Dams – Embankment dams, gravity dams, various components and their functions		2L
Module 2	**Selection of Dam Site:** Site investigations, initial study, reconnaissance survey, geophysical investigations, preliminary selection, evaluation of selected site - various types of foundation testing, field testing and borrow pit investigations, detailed investigations; assessment of foundation characteristics and suitability; selection of type of dam.		6L
Module 3	**Gravity Dam:** Definition, Features of some important gravity dams, Forces acting on a gravity dam, estimation of forces due to: self-weight, water pressure on upstream and downstream face, Uplift pressure, wave pressure, silt pressure, wind pressure, earthquake forces, hydrodynamic forces; Stability analysis - load combinations, codal provisions, modes of failures - overturning, sliding, tension and compression failures, factors of safeties, principal stresses; Elementary profile of a gravity dam - forces acting, minimum base width - no tension, no sliding basis, principal stresses.		10L
Module 4	**Embankment Dams:** Definitions, Features of someimportant embankment dams; Types of embankment dams and their sectional features; Design criteria; Freeboard - necessity, estimation procedure; Seepage analysis - Laplace's flow equations, drainage blanket and rock toe, phreatic line, graphical procedure of drawing phreatic line, estimation of seepage loss; Stability analysis of embankment dams – slip circle method; Seepage Control - cut-offs, slurry trench, sheet piling, grouting, slope protection.		8L
	Diversion headworks: Necessity and uses, different types,		6L

	layout and different components; weirs on permeable foundation, Creep theories, Khosla's method; Different types of modules, Canal escapes, Silt control devices.	
Module 5	**Spillways and Energy Dissipation Structures:** Necessity, types, selection, spillway gates; High overflow ogee spillway - profile, discharge computation, flow equations, factors affecting coefficient of discharge, codal provisions. stilling basins (USBR and BIS) types	**6L**
Reference	1. Hydraulic Structures, Novak, A. I. B. Moffat, C., Nalluri and R. Narayan P, E & FN Spon, UK, 2010. 2. Hydraulic Structures, S. H. Chen, Springer Nature, USA, 2015. 3. Irrigation Engineering and Hydraulic Structures, S. K. Sharma, S. Chand Publishing, New Delhi, 2017. 4. Dams and Appurtenant Hydraulic Structures, A. Tanchev, CRC Press, USA, 2014. 5. Fluid Mechanics and Hydraulic Machines, K. Subramanya, McGraw Hill Education (India) Private Limited, New Delhi, Chennai, 2019.	

PE-CE801C	DISASTER PREPAREDNESS AND PLANNING	3L	3 credits
Course outcome	**After going through this course, the students will be able to:** 1. Define the basic concepts and terminologies disaster management 2. Understand and describe the categories of disaster 3. Realize the roles and responsibilities of a civil engineer towards society in time of a disaster 4. Analyze relationship between development and disasters 5. Apply different concepts of disaster management		
Prerequisite	Class-X level knowledge of Indian Geography and Class-XII level knowledge of Physics, Chemistry, Mathematics, Biology and Environmental Science; Undergraduate level introductory knowledge of Civil and Environmental Engineering		
Module 1	Introduction, Basic Concepts and Definitions Disaster, Hazard, Vulnerability, Risks, Severity, Frequency and details, Capacity, Impact, Prevention, Mitigation		4L
Module 2	Disasters and their Classification, Natural Disasters: Floods, Draught, Cyclones, Volcanoes, Earthquakes, Tsunami, Landslides, Coastal Erosion, Soil Erosion, Forest Fires Manmade Disasters: Industrial Pollution, Artificial Flooding in Urban Areas, Nuclear Radiation, Chemical Spills, Transportation Accidents, Terrorist Strikes Hazard and vulnerability profile of India, Mountain and coastal areas, Ecological fragility		8L
Module 3	Disaster Impacts, Disaster Impacts: Environmental, Physical, Social, Ecological, Economic, Political Health, Psycho-social issues; Demographic aspects (gender, age, special needs); Hazard locations; Global and national disaster trends; Climate change and urban disasters.		8L
Module 4	Disaster Risk Reduction (DRR), Phases of disaster management cycle; Prevention, Mitigation, Preparedness, Relief and recovery; Structural and non-structural measures; Risk analysis, Vulnerability and capacity assessment; Early warning systems, Post- disaster environmental response (water, sanitation, food safety, waste management, disease control, security, communications); Roles and responsibilities of government, community, local institutions,NGOs and other stakeholders; Policies and legislation for disaster risk reduction, DRR programmes in India and the activities of National Disaster Management Authority		10L
Module 5	Disasters, Environment and Development Factors affecting vulnerability such as impact of developmental projects and		8L

	environmental modifications (including of dams, land use changes, urbanization etc.), Sustainable and environmental friendly recovery; Reconstruction and development methods	
Reference	1. Disaster Risk Reduction in South Asia, Pradeep Sahni, Prentice Hall 2. Handbook of Disaster Management: Techniques & Guidelines, Singh B.K., Rajat Publication 3. Disaster Medical Systems Guidelines, Emergency Medical Services Authority State of California, EMSA no.214, June 2003 4. IASC Guidelines on Mental Health and Psychosocial Support in Emergency Settings, Inter Agency Standing Committee (IASC) (Feb. 2007). 5. http://ndma.gov.in/ (Home page of National Disaster Management Authority) 6. http://www.ndmindia.nic.in/ (National Disaster management in India, Ministry of Home Affairs)	

OE-CE801A	**HUMAN RESOURCE DEVELOPMENT AND ORGANIZATIONAL BEHAVIOUR**	**3L**	**3 Credits**
Module 1	**Organizational Behaviour:** Definition, Importance, Historical Background, Fundamental Concepts of OB, Challenges and Opportunities for OB		**2L**
Module 2	**Personality and Attitudes:** Meaning of personality, Personality Determinants and Traits, Development of Personality, Types of Attitudes, Job Satisfaction		**2L**
Module 3:	**Perception:** Definition, Nature and Importance, Factors influencing Perception, Perceptual Selectivity, Link between Perception and Decision Making.		**2L**
Module 4:	**Motivation:** Definition, Theories of Motivation - Maslow's Hierarchy of Needs Theory, McGregor's Theory X & Y, Herzberg's Motivation-Hygiene Theory, Alderfer's ERG Theory, McClelland's Theory of Needs, Vroom's Expectancy Theory.		**4L**
Module 5	**Group Behaviour**: Characteristics of Group, Types of Groups, Stages of Group Development, Group Decision Making.		**2L**
Module 6	**Communication:** Communication Process, Direction of Communication, Barriers to Effective Communication		**2L**
Module 7:	**Leadership:** Definition, Importance, Theories of Leadership Styles		**2L**
Module 8:	**Organizational Politics:** Definition, Factors contributing to Political Behaviour.		**2L**
Module 9:	**Conflict Management:** Traditional vis-a-vis Modern View of Conflict, Functional and Dysfunctional Conflict, Conflict Process, Negotiation – Bargaining Strategies, Negotiation Process.		**3L**
Module 10:	**Organizational Design:** Various Organizational Structures and their Effects on Human Behaviour, Concepts of Organizational Climate and Organizational Culture.		**4L**

	Sl.	Book Name	Author	Publishing House
Reference	1	Organizational Behavior	Robbins, S. P. & Judge, T.A	Pearson
	2	Organizational Behavior	Luthans, Fred	McGraw Hil
	3	Understanding Organizations – Organizational Theory & Practice in India	Shukla, Madhuka	PHI
	4	Principles of Organizational	Fincham, R. & Rhodes, P	Oxford University Press

OE-CE801A	**HUMAN RESOURCE DEVELOPMENT AND ORGANIZATIONAL BEHAVIOUR**	**3L**	**3 Credits**
Module 1	**Organizational Behaviour:** Definition, Importance, Historical Background, Fundamental Concepts of OB, Challenges and Opportunities for OB		**2L**
Module 2	**Personality and Attitudes:** Meaning of personality, Personality Determinants and Traits, Development of Personality, Types of Attitudes, Job Satisfaction		**2L**
Module 3:	**Perception:** Definition, Nature and Importance, Factors influencing Perception, Perceptual Selectivity, Link between Perception and Decision Making.		**2L**
Module 4:	**Motivation:** Definition, Theories of Motivation - Maslow's Hierarchy of Needs Theory, McGregor's Theory X & Y, Herzberg's Motivation-Hygiene Theory, Alderfer's ERG Theory, McClelland's Theory of Needs, Vroom's Expectancy Theory.		**4L**
Module 5	**Group Behaviour**: Characteristics of Group, Types of Groups, Stages of Group Development, Group Decision Making.		**2L**
Module 6	**Communication:** Communication Process, Direction of Communication, Barriers to Effective Communication		**2L**
Module 7:	**Leadership:** Definition, Importance, Theories of Leadership Styles		**2L**
Module 8:	**Organizational Politics:** Definition, Factors contributing to Political Behaviour.		**2L**
Module 9:	**Conflict Management:** Traditional vis-a-vis Modern View of Conflict, Functional and Dysfunctional Conflict, Conflict Process, Negotiation – Bargaining Strategies, Negotiation Process.		**3L**
Module 10:	**Organizational Design:** Various Organizational Structures and their Effects on Human Behaviour, Concepts of Organizational Climate and Organizational Culture.		**4L**

	Sl.	Book Name	Author	Publishing House
Reference	1	Organizational Behavior	Robbins, S. P. & Judge, T.A	Pearson
	2	Organizational Behavior	Luthans, Fred	McGraw Hil
	3	Understanding Organizations – Organizational Theory & Practice in India	Shukla, Madhuka	PHI
	4	Principles of Organizational	Fincham, R. & Rhodes, P	Oxford University Press

OE-CE801C	GROUNDWATER CONTAMINATION	3L	3 Credits
Course Outcome	**On successful completion of this course, student should be able to:** 1. To be able to understand the principles and theories regarding groundwatercontamination 2. To be able to formulate the various remedial measures for groundwater contamination		
Prerequisite	Basic Sciences, Hydrology, Meteorology and Groundwater Hydrology		
Module 1	**Introduction:** Definition of groundwater, hydrological properties of various water bearing strata, vertical distribution of subsurface water, groundwater in hydrologic cycle		**2L**
Module 2	**Groundwater Hydraulics:** Darcy's Law, Dupuit's assumption, Application of Darcy's Law for simple flow systems, Governing differential equations for confined and unconfined aquifers, steady and unsteady flow solutions for fully penetrating wells, partially penetrating wells, Interference of wells, Test pumping analysis with steady and unsteady flows, Delayed yield, method of images		**7L**
Module 3:	**Groundwater quality:** Indian & International standards		**3L**
Module 4:	**Groundwater pollution:** Sources, Remedial and preventive measures		**3L**
Module 5:	**Groundwater conservation:** Groundwater budget, seepage from surface water, artificial recharge withreclamation		**3L**
Module 6:	**Models for Groundwater flow:** Sampling & Monitoring methods, transport mechanisms, modeling (advective and dispersive transport), (adsorption and chemical reaction), biodegradation kinetics, numerical flow and transport modeling, waste site characterization/investigation, groundwater remediation, legal issues in groundwater contamination		**10L**

Reference	**Sl.**	**Book Name**	**Author**	**Publishing House**
	1	Elements of Hydrology and Groundwater	R.N. Saxena & D.C. Gupta	PHI
	2	Groundwater Contamination, Performance,	Anna L Powell	Nova Science Publishers

		Limitations and Impacts		
	3	Groundwater Contamination and Remediation	Editedby Timothy D. Scheibe & David C. Mays	MDPI

OE-CE802A	SOFT SKILL AND PERSONALITY DEVELOPMENT	3L	3 credits
Module 1	**Self-Growth** i) Self-Growth- Maslow's Hierarchy of Needs Theory ii) Anger, Stress & Time Management- Theories and application iii) SWOT Analysis		**6L**
Module 2	**Stepping Up** i) Growth & Environment ii) Competitive Spirit iii) Responsibility Factor		**7L**
Module 3	**Professional Communication** i) Impression Management- theory on social psychology ii) Employability Quotient iii) Cross-cultural communication		**6L**
Module 4	**Leadership & Team Playing** i) Leadership & Team Playing: Theories, Styles, Stages ii) Motivation, Negotiation Skills, Conflict Management iii) Planning & Envisioning: Initiative and Innovation in the Work Environment- De Bono's Six Thinking Hats		**6L**
Reference	1. Personality Development and Soft Skills, Barun K. Mitra, Oxford University 2. Soft Skills: An Integrated Approach to Maxmise Personality, Gajendra Singh, Chauhanand Sangeeta Sharma, Wiley 3. The Ace of Soft Skills: Attitude, Communication and Etiquette for Success, Gopalaswamy Rameshand Mahadevan Ramesh, Pearson		

OE-CE802B	**URBAN HYDROLOGY AND HYDRAULICS**		**3L**	**3 credits**
Course outcome	After going through this course, the students will be able to: 1. develop intensity duration frequency curves for urban drainage systems. 2. develop design storms to size the various components of drainage systems. 3. apply best management practices to manage urban flooding. 4. prepare master drainage plan for an urbanized area.			
Prerequisite	Fluid Mechanics & Hydraulic Machines, Engineering Hydrology and Water Resources Engineering			
Module 1	**Introduction:** Urbanisation and its effect on water cycle – urban hydrologic cycle – trends in urbanisation – Effect of urbanisation on hydrology.			**2L**
Module 2	**Precipitation Analysis:** Importance of short duration of rainfall and runoff data, methods of estimation of time of concentration for design of urban drainage systems, Intensity-Duration - Frequency (IDF) curves, design storms for urban drainage systems.			**4L**
Module 3	**Calculation Methods and Mathematical Tools:** Modelling formulas, Hydrologic models, Hydrodynamic models, Regression analysis, Urban runoff and water quality models			**5L**
Module 4	**Approaches to urban drainage:** Time of concentration, peak flow estimation approaches, rational method, NRCS curve number approach, runoff quantity and quality, wastewater and stormwater reuse, major and minor systems.			**4L**
Module 5	**Elements of drainage systems:** Open channel, underground drains, appurtenances, pumping, source control.			**4L**
Module 6	**Analysis and Management:** Stormwater drainage structures, design of stormwater network- Best Management Practices– detention and retention facilities, swales, constructed wetlands, models available for stormwater management.			**5L**
Module 7	**Master drainage plans:** Issues to be concentrated upon – typical urban drainage master plan, interrelation between water resources investigation and urban planning processes, planning objectives, comprehensive planning, use of models in planning.			**4L**
Reference	Sl.no.	**Book name**	**Author**	**Publishing house**
	1	Urban Hydrology	M. J. Hall	Elsevier Applied Science Publisher
	2	Urban Hydrology, Hydraulics and Stormwater Quality:	A.O. Akan and R.L. Houghtalen	Wiley International

		Engineering Applications and Computer Modelling		
	3	Urban Stormwater Hydrology: A Guide to Engineering Calculations	A.O. Akan	Lancaster Technomic
	4	Stormwater Collection Systems Design Handbook	W. M. Larry	Tata McGraw Hill, New York
	5	Municipal Stormwater Management	R. Deb	Lewis Publishers

<table>
<tr><td>OE-CE802C</td><td colspan="2">ENVIRONMENTAL IMPACT ASSESSMENT AND LIFE CYCLE ANALYSES</td><td>3L</td><td>3 credits</td></tr>
<tr><td>Course outcome</td><td colspan="4">After going through this course, the students will be able to:
1. To understand and evaluate the impact of any activity (large or small scale) on the surrounding environment
2. To be able to formulate mitigation strategies to protect the environment leading to sustainability
3. To be able to understand the intricacies of Life Cycle Analysis and apply basic knowledge for coherent existence</td></tr>
<tr><td>Prerequisite</td><td colspan="4">Basic Sciences, Biology, Environmental Science and Environmental Engineering</td></tr>
<tr><td>Module 1</td><td colspan="3">Introduction Definition, Objective with legal aspect of Environmental Impact Assessment (EIA)</td><td>2L</td></tr>
<tr><td>Module 2</td><td colspan="3">Methodology for EIA with Base Line Studies, Screening , Scoping and Public Consultation</td><td>4L</td></tr>
<tr><td>Module 3</td><td colspan="3">EIA Analysis Data Collection & Environmental Impact Analysis, preparation of EIA report</td><td>5L</td></tr>
<tr><td>Module 4</td><td colspan="3">EIA Mitigation and Audit- Mitigation and Impact Management with various case studies, Environmental Audit</td><td>5L</td></tr>
<tr><td>Module 5</td><td colspan="3">Introduction to Life Cycle Analysis (LCA): History, Definition, Standards and structure of LCA Goal and Scope of LCA: System of a product with boundary, unit process and functional unit</td><td>2L</td></tr>
<tr><td>Module 6</td><td colspan="3">Life Cycle Interpretation and Inventory: Limitation of LCA, Identification of significant issues, Evaluation, Reporting, Critical Review. Inventory: Data Collection, Data Bases, Allocation, Validation</td><td>3L</td></tr>
<tr><td>Module 7</td><td colspan="3">LCA Impact Assessment and Practice: Categories, Classification, Normalization, LCA Management, Life Cycle thinking, Sustainability</td><td>4L</td></tr>
<tr><td rowspan="5">Reference</td><td>Sl.no.</td><td>Book name</td><td>Author</td><td>Publishing house</td></tr>
<tr><td>1</td><td>Environmental Impact Assessment</td><td>R. R. Barthwal,</td><td>New Age International Publication</td></tr>
<tr><td>2</td><td>Environmental Impact Assessment</td><td>Canter</td><td>McGraw Hill Publications</td></tr>
<tr><td>3</td><td>Environmental Impact Assessment: Theory and Practice</td><td>M. Anji Reddy</td><td>B. S. Publication</td></tr>
<tr><td>4</td><td>Environmental Impact</td><td>Peter Wathern</td><td>CRC Press</td></tr>
</table>

		Assessment: Theory and Practice		
	5	Life Cycle Assessment (LCA): A Guide to Best Practice	Walter Klöpffer , Birgit Grahl	Wiley Publishers
	6	Environmental Life Cycle Assessment	Olivier Jolliet, Myriam Saade-Sbeih, Shanna Shaked, Alexandre Jolliet, Pierre Crettaz,	CRC Press
		Life Cycle Student Handbook	Mary Ann Curran,	Scrivener Publishing, Wiley

PR-CE881	PROJECT- II	12P	6 credits
Course outcome	**After going through this course, the students will be able to:** 1. Work in a team and effectively communicate with team members 2. Review and evaluate the literature available related to chosen problem 3. Formulate new expressions, equations to solve that selected problem to enhance problem solving skill 4. Validate theoretical and reported data with results obtained from numerical/ experimental/ analytical study 5. Identify scope of future studies 6. Prepare a report and presentation of project.		
Prerequisite	Undergraduate level knowledge of Civil Engineering		
A final / detailed project to be completed, a Thesis on that topic to be submitted and to be appeared in a seminar to defend the submitted final project.			

PR-CE882	COMPREHENSIVE VIVA VOCE	0P	1 credits
Course outcome	**After going through this course, the students will be able to:** 1. Evaluate overall technical knowledge and industry readiness 2. Analyze various applications of civil engineering in real life problem solving 3. Accustomed with virtual environment of technical interview		
Prerequisite	Undergraduate level knowledge of Civil Engineering		
Each student has to appear for final viva.			

PR-CE883	**SEMINAR**	**0P**	**1 credits**
Course outcome	**After going through this course, the students will be able to:** 1. Choose a topic related to analysis, design, maintenance and management of civil engineering system/process. 2. Carry out review of existing literature in line with the assigned topic. 3. Prepare and present a technical report following standard guidelines. 4. Develop attitude for observational and interpretative skills.		
Prerequisite	Undergraduate level knowledge of Civil Engineering		
Each and every student have to appear in Group Discussion, Self-Introduction, Technical seminar & non-technical seminar on very recent topics.			

PR-CE884	INTERNSHIP EVALUATION	0P	0 credits
Course outcome	**After going through this course, the students will be able to:** 1. Provides an insight to students about what is happening in the real world. 2. Helps students to get practice in works in industry which will be of immense help to them later when they join for jobs in industry after their course completion. 3. Enhance students' knowledge in engineering subjects.		
Prerequisite	Undergraduate level knowledge of Civil Engineering		
Each and every student has to deliver a seminar on Industrial Training conducted after 6th semester.			